DOCUMENT RESUME

ED 261 154 CE 041 977

AUTHOR	Grimes, L. A., Jr.
TITLE	Bricklayer and Stonemason. U.S.O.E. 46.0102 D.O.T. 861.381, 861.781, 861.884. Student's Manual [and] Instructor's Guide.
INSTITUTION	Texas Univ., Austin. Extension Instruction and Materials Center.
SPONS AGENCY	Texas Education Agency, Austin. Dept. of Occupational Education and Technology.
PUB DATE	84
NOTE	228p.; For a related document, see CE 041 976.
AVAILABLE FROM	Extension Instruction and Materials Center, P.O. Box 7218, Division of Continuing Education, University of Texas, Austin, TX 78713-7218 (Stock No. IE 312 S, Student's Manual; Stock No. IE 312 C, Instructor's Guide).
PUB TYPE	Guides - Classroom Use - Materials (For Learner) (051) -- Guides - Classroom Use - Guides (For Teachers) (052)
EDRS PRICE	MF01 Plus Postage. PC Not Available from EDRS.
DESCRIPTORS	*Bricklaying; *Construction (Process); Construction Materials; Course Content; Equipment; Individualized Instruction; *Learning Activities; Learning Modules; *Masonry; Postsecondary Education; *Teaching Methods; Test Items; *Trade and Industrial Education; Work Experience Programs

ABSTRACT

The student's manual in this two-part instructional kit is designed to help students in individualized courses in bricklaying and stone masonry to tie together classroom learning and on-the-job practice. The manual includes assignments, technical information, objectives that tell what the student is to learn from each assignment, and exercise questions that can help in meeting those objectives. The 14 units of the student manual cover the following topics: introduction to the manual, basic mathematics, safety, drawings and blueprints, masonry tools and equipment, masonry materials, elements of masonry construction, wall construction, footings and arches, chimneys and fireplaces, floors and pavements, cleaning clay products, concrete masonry and stone construction, and owning a masonry business. The related instructor's guide contains suggestions on the use of the student manual and on coordinating work experience with learning at school. The guide also contains (1) answers to exercise questions and assignment test questions, (2) one set of assignment tests, and (3) a work sheet that the instructor can use to relate instruction to job experience for students. Coordinated with the student's manual, the guide contains 14 sections corresponding to the manual's 14 units. (KC)

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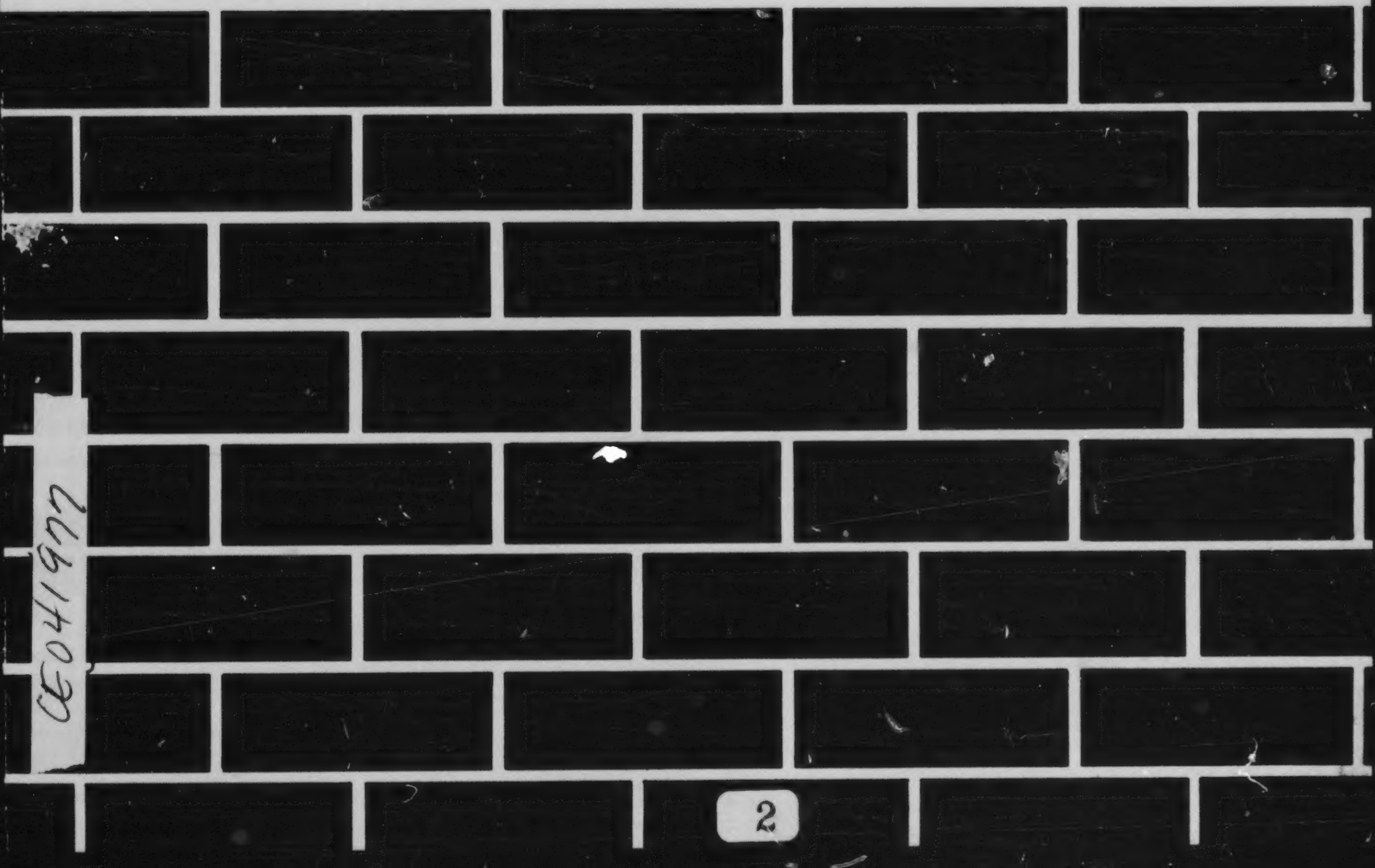

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Bricklayer and Stonemason

Student's Manual

U.S.O.E. 46.0102
D.O.T. 861.381, 861.781, 861.884

By

L.A. Grimes, Jr.

Published by

Extension Instruction and Materials Center
Division of Continuing Education
The University of Texas at Austin

Developed under a contract with

Department of Occupational Education and Technology
Texas Education Agency
Austin, Texas

1984

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Printed in the United States of America

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Stock Number IE 312 S

Contents

Foreword v
Acknowledgments vi
A Special Note to the Student vii

Section A. Introduction to this Manual

A-1: How to Use This Manual 1
A-2: Careers in the Masonry Field 3

Section B. Basic Mathematics

B-1: Adding and Subtracting Common Fractions 7
B-2: Multiplying and Dividing Common Fractions 11
B-3: Decimal Fractions and Conversions 13
B-4: Percentage, Ratio, and Proportion 15
B-5: The Metric System 18
B-6: Developing Areas, Perimeters, and Circumferences 22

Section C. Safety

C-1: General Safety 25
C-2: Handling and Storage 28
C-3: Hand and Power Tool Safety 30

Section D. Drawings and Blueprints

D-1: Reading Blueprints 33
D-2: Angles and Shapes 37
D-3: Types of Drawings 44

Section E. Masonry Tools and Equipment

E-1: Trowels, Hammers, and Equipment 49
E-2: Measuring and Leveling Tools 53
E-3: Mixing and Smoothing Tools 56
E-4: Heavy Masonry Equipment 59

Section F. Masonry Materials

F-1: Cement, Lime, Mortar, and Concrete 65
F-2: Brick, Tile, Block, and Stone 68
F-3: Metal Ties, Steel Bearing Plates, and Flashing 72

Section G. Elements of Masonry Construction

G-1: Brick Bonds 75
G-2: Reinforced Brick 80
G-3: Climatic Conditions 83
G-4: Preparation of Materials 85

Section H. Wall Construction

H-1: Types of Brick Walls 87
H-2: Construction of Brick Walls 91
H-3: Construction of Rubble Stone Walls 97

Section I. Footings and Arches

I-1: Footings 101
I-2: Arch Types, Forms, and Terminology 104
I-3: Arch Construction 108

Section J. Chimneys and Fireplaces

J-1: Chimneys 113
J-2: Fireplaces 116

Section K. Floors and Pavements

K-1: Fundamentals of Masonry Floors 121
K-2: Construction of Masonry Floors 123

Section L. Cleaning Clay Products

L-1: Cleaning New Masonry 127
L-2: Cleaning Old Masonry 131

Section M. Concrete Masonry and Stone Construction

M-1: Concrete-Block and Cut-Stone Trim 133
M-2: Setting Stones 136

Section N. Owning a Masonry Business

N-1: Setting Up a Masonry Business 139
N-2: Human Relations in a Business 142

Glossary 145

Foreword

This publication is one of the Extension Instruction and Materials Center series of individualized instructional materials. Students using this material can work at their own pace, enabling them to concentrate on areas that best fit specific needs. The design of the instruction makes it possible to relate work experience with materials studied at school.

Although the material is designed for individualized study, it should be used under the supervision of an instructor. For that reason, two basic publications are offered—a student's manual and an instructor's guide.

The **student's manual** is for the use of the person in training. It includes assignments, objectives that tell what the student is to learn from each assignment, and exercise questions that can help in meeting those objectives.

The **instructor's guide** has additional information that may help the instructor help the student. There are suggestions on how the student should use the student's manual, and how the instructor can coordinate work experience with learning at school. The instructor's guide also contains (1) answers to exercise questions and assignment test questions, (2) one set of assignment tests, and (3) a work sheet that the instructor can use to relate instruction to job experience for the student.

Although both publications are copyrighted, the instructor should feel free to reproduce the tests and work sheet. These have been placed in a separate section of the guide, where they are readily accessible for copying. If the instructor prefers, copies of this section can be ordered separately for individual students from Extension Instruction and Materials Center, The University of Texas at Austin, P.O. Box 7218, Austin, Texas 78713.

Every effort has been made to produce a publication that addresses the unique needs of our current student population. Students with limited English proficiency (LEP) as well as handicapped, educationally disadvantaged, and nontraditional students may require modification of the material in this publication. The professional staff of EIMC will gladly work with any instructor having these students to show how the instructional material can be adapted for specific individualized instruction. Consult local, state, and federal agencies that offer assistance and guidance and that can provide sound recommendations for productive classroom management.

Kathryn R. Allen, Ph.D.
Director, Extension Instruction and
Materials Center

Acknowledgments

The Extension Instruction and Materials Center of The University of Texas at Austin wishes to acknowledge with grateful appreciation the cooperation and generosity of The Brick Institute of America, The Goldblatt Tool Company, Masonry Specialty Company, and the U.S. Dept. of Agriculture, Farmer's Bulletin #1889 for the use of illustrations and source materials.

We also appreciate the time and effort spent by James R. Wise, business agent, International Union, Bricklayers and Allied Craftsmen, Local #8 of Austin, Texas, in validating this publication.

A Special Note to the Student

The assignments in this manual are designed to help you learn. You will gain more from this material if you know how to work the assignments. For that reason, Assignment A-1 is about how to use this manual and should be completed first.

COMPLIANCE STATEMENT

TITLE VI, CIVIL RIGHTS ACT OF 1964; THE MODIFIED COURT ORDER, CIVIL ACTION 5281, FEDERAL DISTRICT COURT, EASTERN DISTRICT OF TEXAS, TYLER DIVISION

Reviews of local education agencies pertaining to compliance with Title VI Civil Rights Act of 1964 and with specific requirements of the Modified Court Order, Civil Action No. 5281, Federal District Court, Eastern District of Texas, Tyler Division are conducted periodically by staff representatives of the Texas Education Agency. These reviews cover at least the following policies and practices:

(1) acceptance policies on student transfers from other school districts;

(2) operation of school bus routes or runs on a non-segregated basis;

(3) nondiscrimination in extracurricular activities and the use of school facilities;

(4) nondiscriminatory practices in the hiring, assigning, promoting, paying, demoting, reassigning, or dismissing of faculty and staff members who work with children;

(5) enrollment and assignment of students without discrimination on the basis of race, color, or national origin;

(6) nondiscriminatory practices relating to the use of a student's first language; and

(7) evidence of published procedures for hearing complaints and grievances.

In addition to conducting reviews, the Texas Education Agency staff representatives check complaints of discrimination made by a citizen or citizens residing in a school district where it is alleged discriminatory practices have occurred or are occurring.

Where a violation of Title VI of the Civil Rights Act is found, the findings are reported to the Office for Civil Rights, Department of Health, Education and Welfare.

If there is a direct violation of the Court Order in Civil Action No. 5281 that cannot be cleared through negotiation, the sanctions required by the Court Order are applied.

TITLE VII, CIVIL RIGHTS ACT OF 1964: EXECUTIVE ORDERS 11246 and 11375; TITLE IX 1973 EDUCATION AMENDMENTS: REHABILITATION ACT OF 1973 AS AMENDED; 1974 AMENDMENTS TO THE WAGE-HOUR LAW EXPANDING THE AGE DISCRIMINATION IN EMPLOYMENT ACT OF 1967; VIETNAM ERA VETERANS READJUSTMENT ASSISTANCE ACT OF 1972 AS AMENDED IN 1974.

It is the policy of the Texas Education Agency to comply fully with the nondiscrimination provisions of all federal and state laws and regulation by assuring that no person shall be excluded from consideration for recruitment, selection, appointment, training, promotion, retention, or any other personnel action, or be denied any benefits or participation in any programs of activities which it operates on the grounds of race, religion, color, national origin, sex, handicap, age, or veteran status (except where age, sex, or handicap constitute a bona fide occupational qualification necessary to proper and efficient administration). The Texas Education Agency makes positive efforts to employ and advance in employment all protected groups.

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A-1

How to Use This Manual

Objectives*: After completing this assignment, you will be able to—*

1. *state the purpose of a student's manual;*
2. *discuss the reasons for the assignment objectives;*
3. *discuss the procedure to use when studying the information part of an assignment;*
4. *discuss the uses of the assignment exercises; and*
5. *tell how the assignment tests are used.*

Purpose of a Student's Manual

A student's manual is designed to present technical instructions, procedures, and illustrations to groups of trade and industrial students. It may also be used by other groups in which the learning levels of individual students vary considerably. It is not intended to be used as a correspondence course, but must be used by students under the direct supervision of an instructor.

Information in the student's manual is designed to be read at about the same time that related work is being done on-the-job. For example, while the student is learning on-the-job about how to erect a brick wall, he or she should be reading about types of bricks, bonds, and types of walls in the student's manual. This combination of classroom study and on-the-job experience gives the student well-rounded knowledge and experience in each specific operation.

Parts of an Assignment

Objectives. In order for the student to know what he or she should learn, each assignment begins with a list of objectives. The student should study the objectives before reading the information part of the assignment. After finishing the assignment, the student should reread the objectives to see if he or she has succeeded in meeting them. Success is checked through the use of the exercises and tests.

Information. All the information for each assignment is given in the assignment itself. The exercise and test for each assignment are based on the information in that assignment. The student should read all the information carefully before answering the exercise questions. Illustrations—which may include tools and materials, as well as certain procedures and operations—should also be studied. When answering the exercise questions, the student should reread any information that is unclear. Certain on-the-job tasks may also make it necessary to refer to the assignment information.

Exercises. The exercise questions are based on the information given in the assignment and are designed to help the student meet the objectives. The student should write both the questions and the answers on separate sheets of paper. The answers should be complete sentences. After the instructor has checked the exercise questions, the student should correct any mistakes and place the papers in his or her notebook. If the exercise questions have been answered correctly, the objectives stated at the beginning of the assignment have been met. The exercise questions in this manual are designed to make the student think. The student should consider each question carefully before writing an answer.

Tests. The assignment test is a short quiz that may be answered very quickly. A test may be given as soon as the specific assignment has been completed, or several tests may be combined and given together as a weekly or six-weeks' test. The assignment test questions are either fill-in-the-blank or multiple-choice questions.

Exercise

1. What is a student's manual designed to present to the student?
2. What combination gives the student well-rounded knowledge and experience about each specific operation?
3. Name the four parts of an assignment.
4. When should the assignment objectives be studied?
5. What should the student do before trying to answer the exercise questions?
6. What may be shown in the illustrations?
7. When is it sometimes necessary to reread information in the assignment?
8. What is the purpose of the exercise questions?
9. How should the answers to exercise questions be written?
10. What should students do with the exercise questions as soon as they have been checked by the instructor?
11. When may it be assumed that the assignment objectives have been met?
12. What are the exercise questions in this student's manual designed to do?
13. When may assignment tests be given?
14. What types of questions are found in the assignment tests?

A-2

Careers in the Masonry Field

Objectives: *After completing this assignment, you will be able to—*

1. *describe various types of jobs performed by bricklayers and stonemasons;*
2. *name locations where masonry workers normally find employment;*
3. *list the requirements for apprenticeship in the masonry trades;*
4. *give the employment outlook for masonry workers in the 1980s; and*
5. *discuss the advantages and disadvantages of masonry as a trade.*

Types of Work

Bricklayers and stonemasons (masons) work in closely related trades. Bricklayers construct walls, walks, patios, partitions, fireplaces, and other structures with brick, cinder block, and other masonry materials. They are also responsible for installing firebrick linings in industrial furnaces.

Stonemasons also build walls, walks, and patios. However, they work with natural stone, such as limestone, granite, and marble, and artificial stone made from marble chips, cement, and other masonry materials. Stonework is usually found on large buildings, such as churches, hotels, and offices; but it is also used on houses where stone is plentiful.

When erecting a wall, bricklayers first construct the corners at each end of the wall with a level and plumblines. A line is stretched from one corner to the other to be used as a guide for the first course or row of bricks. This line is moved upward for each succeeding course. Bricklayers spread a bed of mortar on the brick with a trowel. A brick is placed on the mortar and tapped in place, then excess mortar is raked off. Bricks are broken or cut with a hammer and chisel to fit windows, doors, and other openings. Mortar joints are finished with jointing tools to give a smooth and uniform appearance. Steel supports may be installed at window and door openings.

Hod carriers assist the bricklayers by keeping them supplied with bricks or other materials. They also mix mortar and set up and move scaffolding.

Masons must be able to read blueprints in order to understand the specifications of the particular job. The stonemason may use a set of drawings that includes numbered stones, so that each stone is placed in a specific location.

Stonemasons construct walls by setting the first course of stones into a shallow bed of mortar. Large stones may be placed through the use of hoists. The stones are aligned with plumblines and levels. A wooden mallet is used to tap them in place. Joints between the stones are filled with mortar using a trowel. Stonemasons often position pieces of metal within a wall to hold the stones in place. This metal may be welded or bolted together, and is then covered with mortar. Stones are cut with a special hammer or saw. Acid is used on the finished wall to remove dirt and dry mortar.

Masons also repair brick and stone walls by filling cracks with mortar or by removing and replacing damaged brick or stone.

Bricklayers and stonemasons mainly use hand tools such as trowels, brick and stone hammers, mallets, chisels, plumb bobs, levels, and measuring devices. Electric saws with masonry blades may be used for cutting. Wheelbarrows are often used to transport mortar to the working area.

Places of Employment

There are over 200,000 bricklayers and stonemasons, although most are bricklayers. Many bricklayers install stone as a sideline. Approximately 75 percent of these workers are employed by trade, building, or general contractors. The other 25 percent are self-employed. These masons do more small jobs, such as mailbox posts, walks, patios, and fireplaces.

Qualifications and Advancement

Most bricklayers and stonemasons attain their skills by working as helpers or hod carriers for experienced workers. Others learn their skills by participating in apprenticeship programs. These programs are usually sponsored by local contractors or union management committees, and require 3 years of on-the-job training and 144 hours of classroom instruction. Subjects covered are blueprint reading, layout and sketching, and mathematics. While working on the job, apprentices learn the procedures and methods for working with various masonry materials.

Applicants for an apprenticeship program must be at least 17 years old and in good physical condition. Hearing-impaired individuals should have no difficulty in working in this trade. A high school or vocational school education is preferred. Helpful high school courses include mathematics, mechanical drawing, and shop. Workers may advance to supervisory or estimating positions, or begin their own masonry businesses.

Employment Outlook

Through the 1980s, employment of bricklayers is expected to grow more slowly than that of other industrial occupations. Some job openings will be due to experienced bricklayers retiring, dying, or leaving the occupation. The number of openings will change from year to year as reflected by changes in the economy.

Employment of stonemasons will remain about the same during the 1980s. No increase is expected due to the rising costs of building with stone.

Earnings and Working Conditions

The average union wage for bricklayers is about $14.00 per hour, with stonemasons earning slightly more. Yearly earnings for workers in these trades are usually lower than the hourly wages reflect because of lost working days due to poor weather.

Beginning apprentices are usually paid about 50 percent of the wage paid to experienced masons. A large percentage of bricklayers and stonemasons are members of the Bricklayers, Masons, and Plasterers' International Union of America.

Bricklayers and stonemasons usually work outside, so are subject to extreme weather conditions. They sometimes have to stand, kneel, or stoop for long periods of time, and heavy lifting is necessary at times. They may be injured by hand tools, bricks, and stones, and falls from scaffolds. However, although there are many hazards, masonry workers are less likely to be injured than other construction workers.

Exercise

1. What do bricklayers construct?
2. What natural stones are used by stonemasons?
3. On what types of buildings is stonework usually found?
4. What does the bricklayer use as a bed for brick?
5. What type of repair work is done by masons?
6. Where are about 75 percent of the bricklayers employed?
7. What training is required in masonry apprenticeship programs?

8. How old must an applicant be for acceptance in the apprenticeship program?
9. What is the employment outlook for bricklayers in the 1980s?
10. What is the primary advantage of being a masonry worker as compared to other construction workers?
11. Name the disadvantages of working in the masonry trades.

B-1

Adding and Subtracting Common Fractions

Objectives: *After completing this assignment, you will be able to—*

1. *discuss the meaning of fractions;*
2. *work problems adding common fractions; and*
3. *work problems subtracting common fractions.*

The Meaning of Fractions

A **fraction** is a part of a whole. Since the bricklayer works with rules and tapes that show measurements in parts of inches and feet, it is important to know how to figure in inches and fractions of an inch.

If a whole object is cut into 2 parts, each part equals 1/2 of the whole, or 1 of 2 parts. If the object is cut into 4 parts, each part equals 1/4 of the whole, or 1 of 4 parts. Figure 1 shows two examples of shapes that have been cut into a number of smaller parts—or fractional parts—of the whole object.

The bricklayer uses many types of rules and squares for measuring. The 12-inch rule is divided into 12 equal parts or inches. This means that each inch is equal to 1/12 of the total length of the rule, or 1 part of the whole 12 inches. Figure 2 shows how one part of the rule is equal to a number of smaller parts. On the shaded part of the rule, 1/3 of the rule is the same as 2/6 of the rule or 4/12 of the rule.

Each of the two numbers in a fraction is identified by a name. The number above the line is the **numerator.** The number below the line is the **denominator.**

$\underline{1}$ (numerator)
8 (denominator)

Reducing to Lowest Terms

One of the basic operations you will perform with fractions is called **reducing to lowest terms.** Suppose you have these fractions:

$$\frac{1}{2} \quad \frac{2}{8} \quad \frac{4}{16}$$

The operation used to reduce these fractions to their lowest terms is called **cancellation.** To cancel, divide the largest possible number (other than 1) that will go evenly into both the numerator and denominator of the fraction. The fraction 1/2 is already reduced to its lowest terms. It cannot be divided evenly by any number other than 1. The largest number that can be divided evenly into the fraction 2/8 is 2. The largest number that will go into 4/16 evenly is 4. These fractions are now reduced to their lowest terms by cancelling out the numbers you are reducing and writing in the new numbers as you divide:

$$\frac{1}{2} \quad \frac{\overset{1}{\cancel{2}}}{\underset{4}{\cancel{8}}} \quad \frac{\overset{1}{\cancel{4}}}{\underset{4}{\cancel{16}}}$$

Finding the Lowest Common Denominator

Just as apples and oranges cannot be added together or subtracted from each other,

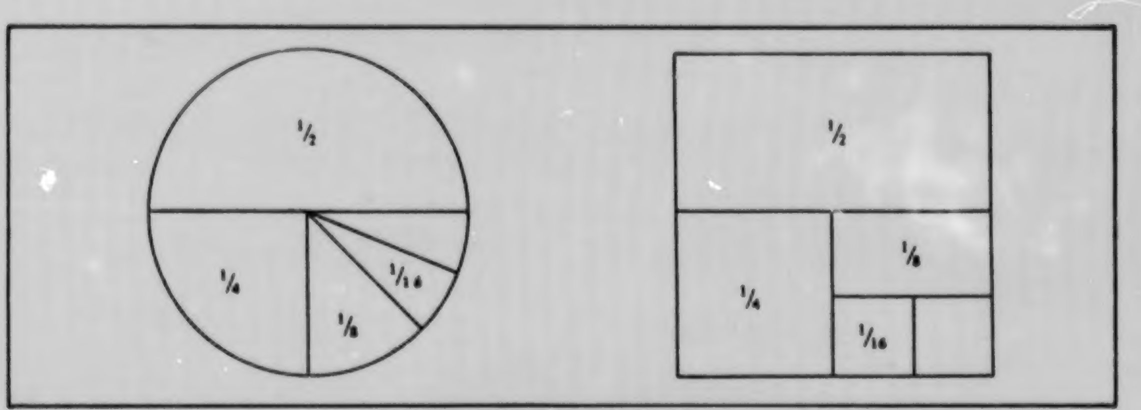

1/2
1/4
1/8
1/16
1/2
1/8
1/4
1/16

Figure 1. Fraction Examples

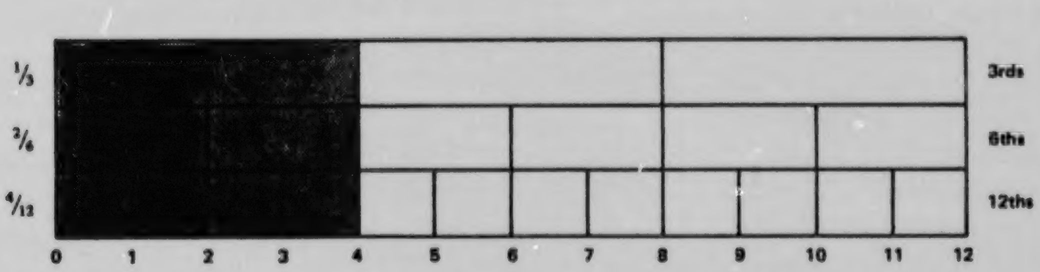

1/3
2/6
4/12
3rds
6ths
12ths
0
1
2
3
4
5
6
7
8
9
10
11
12

Figure 2. Dividing Lengths into Fractions

fractions with different denominators cannot be added together or subtracted from each other. Suppose, after reducing them to their lowest terms, you want to add together:

$$\frac{1}{2} + \frac{1}{4} + \frac{1}{4} =$$

To add or subtract fractions with different denominators you must first perform an operation which makes all the denominators the same without changing the value of the fraction. This is called **finding the lowest common denominator.** The lowest common denominator is the lowest number into which the denominator of each of the fractions you want to add or subtract will divide evenly. In the case of 1/2, 1/4, and 1/4, the lowest number all three denominators will divide into is 4. The fractions 1/4 and 1/4 already have that denominator. When you change the denominator of 1/2 into 4, to avoid changing the value of the fraction, you must also change the numerator. To get the new numerator, divide the old denominator into the lowest common denominator and multiply the old numerator by the number you get. In this case, the result is 2/4. The fraction 2/4 has the same value as 1/2, but it can be added or subtracted with other fractions with a lowest common denominator of 4.

Sometimes the lowest common denominator is not as obvious as it was above. Say you want to add:

$$\frac{1}{4} + \frac{1}{3} = \_\_\_\_$$

Find the common denominator by multiplying the two denominators (3 and 4) together. The common denominator for these two fractions is 12. Both fractions are then changed to twelfths. To get the new numerators, follow the same procedure you did above. Divide 4 into 12 and multiply this number by the old numerator, 1, which gives you 3/12; divide 3 into 12 and multiply this number by the numerator, 1, to give you 4/12. Now that they have a common denominator, 12, these two fractions can be added or subtracted.

Types of Fractions

A fraction with a denominator larger than the numerator is a **proper fraction.** The fraction 1/3 is an example of a proper fraction. If the fraction has a numerator that is larger than the denominator, it is an **improper fraction.** The fraction 3/2 is an example of an improper fraction.

Mixed numbers contain both a whole number and a proper fraction. The number 2 1/4 is an example of a mixed number. When changing a mixed number to an improper fraction, multiply the whole number by the denominator of the fraction, and add this number to the numerator of the fraction. For instance, to change 2 1/4 to an improper fraction, multiply 2 by 4 and add 1. The resulting improper fraction is 9/4. To change an improper fraction to a mixed number, divide the numerator by the denominator. To change the improper fraction 5/2, 2 is divided into 5. The mixed number is then 2 1/2.

Adding Common Fractions

To add common fractions:

1. Find the lowest common denominator, if necessary.
2. Add the numerators.
3. Write the sum of the numerators over the common denominator.
4. Reduce the fraction to its lowest terms, if necessary.

When the denominators are different, the common denominator must be found. To add:

1/4 + 1/8 = ____

Find the lowest common denominator (8). The fraction 1/4 changes into eighths by dividing 4 into 8 and multiplying the answer, 2, by the numerator. The resulting fraction is 2/8. Now that they have a common denominator, the two fractions can be added: 2/8 + 1/8 = 3/8, which does not reduce. Sometimes, more than two fractions are added together. For example:

1/2 + 1/3 + 1/5 = ____

The denominators 2 and 3 will not divide into 5. In this case, all three denominators must be multiplied together to find a common denominator. Thus, 2 X 3 X 5 = 30; the common denominator is 30. Change each fraction to this denominator. Then the problem is:

15/30 + 10/30 + 6/30 = 31/30

When you change this fraction to a mixed number, the answer is 1 1/30.

Mixed numbers are added as shown in the following examples.

$$\begin{array}{r} 1\ 3/4 \\ \underline{+\ 3\ 1/4} \\ 4\ 4/4 \text{ or } 5 \end{array} \qquad \begin{array}{r} 4\ 3/8 \\ \underline{+\ 5\ 1/2} = 4/8 \\ 9\ 7/8 \end{array} \qquad \begin{array}{r} 1\ 1/8 \\ 2\ 1/4 = 2/8 \\ \underline{+\ 4\ 1/2} = 4/8 \\ 7\ 7/8 \end{array}$$

Subtracting Common Fractions

To subtract fractions that have the same denominator, follow the same procedure as for addition except that one numerator is subtracted from the other. For example, 1/8 subtracted from 3/8 equals 2/8, which can be reduced to 1/4. When the denominators are different, find the lowest common denominator. To subtract 3/16 from 1/4: Find the lowest common denominator (16). The fraction 1/4 is then changed to 4/16. When 3/16 is subtracted from 4/16, the answer is 1/16.

Mixed number problems are worked similarly, except when subtracting a larger fraction from a smaller one. When this happens, a whole number is borrowed and added to the smaller fraction. For example:

2 1/8 - 1 3/8 = ____

Borrow a whole number from 2 (which leaves the mixed number 1 1/8); the whole number equals 8/8. Add 8/8 to 1 1/8. The problem now reads 1 9/8 - 1 3/8. The answer is 6/8, which reduces to 3/4.

Exercise

1. Define the word **fraction.**
2. If an object is divided into four parts, how is the fraction for one part written?
3. How many sixths does the fraction 1/3 contain?
4. What is the number above the horizontal line in a fraction called?
5. What is the number below the horizontal line in a fraction called?
6. What is the process of making all denominators the same without changing the value of the fraction?
7. What type of fraction has a numerator that is larger than the denominator?
8. What are mixed numbers?
9. What is a common denominator?
10. What must be done when subtracting mixed numbers and a larger fraction must be subtracted from a smaller one?
11. Work the following addition problems:
    (1) 1/4 + 1/6 = ____
    (2) 1/3 + 4/7 = ____
    (3) 3/8 + 1/2 = ____
    (4) 2/5 + 1/7 = ____
    (5) 1/9 + 1/6 = ____
12. Work the following subtraction problems:
    (1) 2/4 - 1/8 = ____
    (2) 7/8 - 2/5 = ____
    (3) 3/4 - 1/3 = ____
    (4) 2/9 - 3/18 = ____
    (5) 5/7 - 2/9 = ____

B-2

Multiplying and Dividing Common Fractions

Objectives: *After completing this assignment, you will be able to—*

1. *define terms and give rules used in multiplying fractions;*
2. *define terms and give rules used in dividing fractions;*
3. *work problems multiplying common fractions; and*
4. *work problems dividing common fractions.*

Definitions of Multiplication Terms

Confusion may arise if the terms used are not clear to the person working a problem. The **multiplicand** is the number to be multiplied by another number. The **multiplier** is a number which multiplies the multiplicand. The **product** is the answer you get when the two numbers are multiplied together.

Multiplying Fractions

Four different basic operations for multiplying fractions are common. The first three operations are used more often by the bricklayer and should be learned. (1) Two fractions (1/4 x 1/8) may be multiplied together. (2) A fraction and a whole number (1/2 x 8) may be multiplied. (3) A mixed number and a whole number (3 1/2 x 4) may be multiplied. (4) Two mixed numbers (3 1/9 x 2 1/4) are seldom multiplied by the bricklayer. There are different rules for each operation.

To multiply a fraction by a fraction—Multiply the numerator of one fraction by the numerator of the other to get the numerator of the product. Then multiply the denominators together to get the denominator of the product. For example,

$$\frac{1}{4} \times \frac{1}{8} = \frac{1 \times 1}{4 \times 8} = \frac{1}{32}$$

To multiply a fraction by a whole number—Multiply the numerator of the fraction by the whole number, then divide the result by the denominator. For example,

$$5 \times \frac{3}{4} = \frac{5 \times 3}{4} = \frac{15}{4} = 3\frac{3}{4}$$

Notice that in this problem the product is an improper fraction. The denominator (4) is divided into the numerator (15). This gives an adjusted product of 3 whole numbers and 3/4 of a whole number, or 3 3/4.

Sometimes, **cancellation** is used to simplify the problem, when a common number can be divided evenly into both the numerator and the denominator. The example below shows cancellation.

$$\frac{4}{8} \times 16 = \frac{4 \times \overset{2}{\cancel{16}}}{\underset{1}{\cancel{8}}} = \frac{8}{1} = 8$$

The number 8 is used as a common number and is divided into both the numerator (16) and the denominator (8). The numerators are multiplied, giving a numerator of 8; and the denominator is 1. The fraction 8/1 equals 8.

To multiply a mixed number by a whole number—Multiply the fractional part of the mixed number by the whole number. Then multiply the whole numbers and add the two products as in the following example.

$$\begin{aligned} 2\tfrac{1}{2} \times 4 = \tfrac{1}{2} \times 4 = \tfrac{4}{2} &= 2 \\ + 2 \times 4 &= 8 \\ \hline &10 \end{aligned}$$

Another way to multiply these numbers is shown in the example below.

$$2\frac{1}{2} \times 4 = \frac{5}{2} \times 4 = \frac{5 \times \overset{2}{\cancel{4}}}{\underset{1}{\cancel{2}} \times 1} = \frac{10}{1} = 10$$

Definitions of Division Terms

In division, the **dividend** is the number that is divided. The **divisor** is the number that divides into a dividend. The **quotient** is the number that results from the division of one number by another.

Dividing Fractions

Five different operations are possible in dividing fractions. (1) A fraction may be divided by a whole number, or (2) by another fraction. (3) A mixed number may be divided by a whole number or (4) by another mixed number. (5) A whole number may be divided by a fraction. Each operation requires a different rule. The bricklayer normally performs the first three operations.

To divide a fraction by a whole number—Multiply the denominator of the fraction by the whole number. For example,

$$\frac{3}{4} \div 2 = \frac{3}{4 \times 2} = \frac{3}{8}$$

In figure 1, the length is divided into four parts (4/4). The problem is to divide 3/4 by 2, or to divide 3/4 of a whole into 2 parts. Figure 1 shows that each half of 3/4 equals 3/8.

To divide a fraction by another fraction—Invert the divisor fraction and work the problem as a multiplication. To invert a fraction means to turn it upside down. The fraction (1/2) is inverted (2/1).

$$\frac{1}{4} \div \frac{1}{2} = \frac{1}{4} \times \frac{2}{1} = \frac{1 \times 2}{4 \times 1} = \frac{2}{4} = \frac{1}{2}$$

To divide a mixed number by a whole number—Change the mixed number to an improper fraction and then divide as shown in the example below.

$$3\frac{1}{4} \div 4 = \frac{13}{4} \div \frac{4}{1} = \frac{13}{4} \times \frac{1}{4} = \frac{13}{4 \times 4} = \frac{13}{16}$$

Exercise

1. Define multiplicand.
2. Define multiplier.
3. What is the rule for multiplying a fraction and a whole number?
4. What is the rule for multiplying a fraction by a fraction?
5. Define divisor.
6. What is the rule for dividing a fraction by a whole number?
7. What does inverting a fraction mean?
8. Work the following multiplication problems:
   (1) 3/4 x 6/7 = ____
   (2) 1/10 x 3/4 = ____
   (3) 8/9 x 3 = ____
   (4) 1/6 x 3/5 = ____
9. Work the following division problems:
   (1) 1/4 ÷ 1/8 = ____
   (2) 1/3 ÷ 1/6 = ____
   (3) 5 1/2 ÷ 6 = ____
   (4) 2 2/3 ÷ 3 = ____

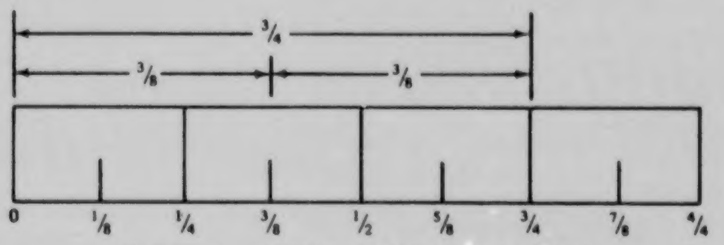


Figure 1. Dividing 3/4 into Two Parts

B-3

Decimal Fractions and Conversions

Objectives: *After completing this assignment, you will be able to—*

1. *add and subtract decimal fractions;*
2. *multiply and divide decimal fractions;*
3. *convert fractions to decimals; and*
4. *convert decimals to fractions.*

Decimal Fractions

In the metric system, fractional quantities are always expressed as **decimal fractions,** in which the denominator is ten or a multiple of ten and is understood rather than expressed.

A simple rule for determining the number of zeros in the denominator is to remember that there are the same number of zeros in the denominator as there are figures to the right of the decimal point in the fraction. For example,

0.1 is read one-tenth (1/10).
0.02 is read two-hundredths (2/100).
0.003 is read three-thousandths (3/1000).
0.0004 is read four ten-thousandths (4/10000).
0.00005 is read five hundred-thousandths (5/100000).
0.000006 is read six-millionths (6/1000000).
1.1 is read one and one-tenth (1 1/10).

Addition. Add as if you were adding whole numbers. Write the quantities down so that the decimal points come under one another, and then proceed with simple addition. The following examples show both simple and more difficult forms of adding decimal fractions.

$$\begin{array}{r} 0.03 \\ +0.21 \\ \hline 0.24 \end{array} \qquad \begin{array}{r} 10.3 \\ +\ 9.7 \\ \hline 20.0 \end{array} \qquad \begin{array}{r} 3.040 \\ 0.005 \\ +\ 8.014 \\ \hline 11.059 \end{array}$$

Subtraction. Subtract decimal fractions the same as in simple subtraction. Be sure that the decimal points line up. Some examples follow.

$$\begin{array}{r} 43.2 \\ -\ 9.1 \\ \hline 34.1 \end{array} \qquad \begin{array}{r} 20.3 \\ -12.8 \\ \hline 7.5 \end{array} \qquad \begin{array}{l} 3.0132 \\ -0.24 \\ \hline 2.7732 \end{array}$$

Multiplication. Multiply as if you were multiplying whole numbers. Mark off to the left as many decimal places in the product as you have in both the multiplier and the multiplicand. Example:

$$\begin{array}{rl} 0.45 & \text{(2 decimal places in multiplicand)} \\ \times\ 0.4 & \text{(1 decimal place in multiplier)} \\ \hline 0.180 & \text{(3 decimal places in product)} \end{array}$$

Division. Divide as if you were dividing whole numbers. Move the decimal point in the divisor to the far right of the number (2.2 would become 22.). Move the decimal point in the dividend the same number of spaces to the right that you moved the decimal in the divisor (7.48 would become 74.8). If the divisor has no decimal, do not move the decimal in the dividend. Two examples follow:

```
7.48 ÷ 2.2          3.4
               22.)74.8
                   66
                   88
                   88
                    0
```

```
                          2.70 (quotient)
5.40 ÷ 2    (divisor) 2)5.40 (dividend)
                         4
                         1.4
                         1.4
                           0
```

Converting Fractions to Decimals

To change a common fraction to a decimal fraction, divide the numerator by the denominator. For example,

```
                  0.25
1/4 = 1 ÷ 4 = 4)1.00
                  8
                  20
                  20
                   0
```

Converting Decimals to Fractions

To change a decimal into a common fraction, omit the decimal point, write the denominator, and reduce to the lowest terms. Examples:

0.4 = 4/10 = 2/5
0.25 = 25/100 = 1/4

Exercise

1. How are fractional quantities expressed in the metric system?
2. Write three-thousandths as a decimal fraction.
3. Add the following problems in decimal fractions.
   (1) 20.4 + 10.1 = _____
   (2) 13.42 + 0.923 = _____
4. Subtract the following problems in decimal fractions.
   (1) 9.9 - 2.7 = _____
   (2) 52.30 - 1.60 = _____
5. What is the rule for multiplying decimal fractions?
6. Multiply the following problems in decimal fractions.
   (1) 0.61 x 0.3 = _____
   (2) 3.124 x 0.4 = _____
7. Divide the decimal fraction 5.6 by 2.8.
8. Convert the following fractions to decimals.
   (1) 1/2 = _____
   (2) 3/8 = _____
   (3) 1/6 = _____
   (4) 3/5 = _____
9. Convert the following decimals to fractions.
   (1) 0.5 = _____
   (2) 0.75 = _____
   (3) 0.0175 = _____
   (4) 0.0475 = _____

B-4

Percentage, Ratio, and Proportion

Objectives: *After studying this assignment, the student will be able to—*

1. *convert percentages to fractions and fractions to percentages;*
2. *convert percentages to ratios and ratios to percentages; and*
3. *convert percentages to decimals and decimals to percentages.*

Often, it is necessary for the bricklayer or stonemason to deal with percentages, ratios, and proportions. The purpose of the simple rules for conversion and the sample problems given in this assignment is to acquaint you with the types of problems you may encounter during cost or material estimating and various mixing processes.

Rules for Conversion

The following examples illustrate the rules for converting percentages to fractions, ratios, or decimals; fractions, decimals, and ratios to percentages; and fractions of a percent to fractions and ratios.

1. Percentage to Fraction
   Example:
   Convert 5 percent to a fraction.
   Percent (%) means hundredths.
   5% = 5/100
2. Percentage to Ratio
   Example:
   Express 5 percent as a ratio.
   5% = 5/100 = 1/20 = 1:20
   5% = 1:20
3. Percentage to Decimal
   Example:
   Express 5 percent as a decimal.
   Omit the percent sign (%) and express the number in hundredths by using decimals.
   5% = 5/100 = 0.05
   5% = 0.05
4. Fraction to Percentage
   Example:
   Express 1/5 as a percent.
   Multiply by 100 and add the percent sign (%).
   1/5 x 100 = 20
   1/5 = 20%
5. Decimal to Percentage
   Example:
   Convert 0.05 to a percentage.
   Move the decimal point two places to the right and add the percent sign (%).
   0.05 = 5%
6. Ratio to Percentage
   Example:
   Express the ratio 1:5 as a percentage.

Express the ratio as a fraction, multiply by 100, and add the percent sign (%).
1:5 = 1/5
1/5 x 100 = 20%
1:5 = 20%

7. Fraction of a Percent to a Fraction or Ratio
   Example:
   Express 0.5% as a fraction and as a ratio. To change a fraction of a percent to a fraction or a ratio, add two zeros to the denominator.
   0.5% = 5/10 + 00 = 5/1000 = 5:1,000 = 1:200
   0.5% = 5/1,000
   0.5% = 1:200

Ratio and Percentage

A ratio is another way of expressing a fractional part of a whole. Instead of writing the numerator above the denominator, the numerator is written first, followed by the denominator with either a (-) or (:) between them.

Examples: 1/5 = 1-5 (or 1:5)
1/500 = 1-500 (or 1:500)

In using words to denote a ratios, one frequently uses the expressions, "one in five" or "one to five" (instead of "one-fifth") or "one in five hundred" or "one to five hundred" (instead of "one five hundredth"). In changing a ratio to a fraction, the first numeral becomes the numerator, the second the denominator.

Examples: 1-1,000 = 1/1000
3:200 = 3/200

The procedure for changing a ratio to a percentage or a decimal is, therefore, the same as that for changing a fraction to a percentage or a decimal. Converting a decimal to a ratio would be the same as converting a decimal to a fraction. Converting a percentage to a ratio would be the same as changing a percentage to a fraction.

Examples: Ratio to percentage: 1:5 = 1/5 = 20%
Percentage to ratio: 20% = 20/100 = 1/5 = 1-5 (or 1:5)
Decimal to ratio: 0.55 = 55/100 = 11-20 (or 11:20)

Proportion

In mathematics, a proportion is the statement of an equality or equal relationship between two ratios or fractions. Either (::) or (=) is used to express this equality.

Examples: 1:2 :: 2:4
or 1:2 = 2:4
or 1/2 = 2/4

2:3 :: 4:6
or 2:3 = 4:6
or 2/3 = 4/6

In every true proportion expressed as an equality between two ratios, the product obtained by multiplying the two middle numbers (the means) is always exactly equal to the product of the numbers at each end (the extremes). This can be illustrated using the same examples just given.

Examples: 1:2 = 2:4
2 x 2 = 4 (means)
1 x 4 = 4 (extremes)

2:3 = 4:6
3 x 4 = 12 (means)
2 x 6 = 12 (extremes)

This fact gives us a very useful mathematical device. If any one or part of one of the factors is not known, we can determine the unknown. Two of the numbers can be multiplied and the product of these two numbers can be divided by the third known factor to get the unknown factor. This procedure is just another application of the principle used in proving multiplication problems—that is, dividing the product by either multiplier or multiplicand gives the other number as a quotient. It is customary to represent the unknown by the letter x.

Example: 5:60 :: x:48
60x = 240 (multiply the means and the extremes)
x = 4 (divide each side of the equal sign by 60)
Proof: 5:60 :: 4:48
240-240

Example: 5:(x - 32) :: 5:9
5(x - 32) = 45 (multiply the means and the extremes)
5x - 160 = 45 (multiply everything in parentheses by 5)

5x = 45 + 160 (add 160 to each side of the equal sign)
5x = 205 (add 45 and 160)
x = 41 (divide each side by 5)

Proof: 5:(41 - 32) :: 5:9
5:9 = 5:9
45 = 45

Note that in the last example only part of the second factor is known. Both the "x" and "– 32" are multiplied by 5. In transferring it to the other side of the equation, the -160 is changed to a +160. When transporting a plus quantity to the other side of an equation, the number is subtracted or the sign is changed to minus (-).

Exercise

1. Convert the following percentages to fractions:
   (1) 5% = ______
   (2) 20% = ______
   (3) 40% = ______
2. Convert the following fractions to percentages:
   (1) 3/4 = ______
   (2) 1/10 = ______
   (3) 3/20 = ______
3. Convert the following percentages to ratios:
   (1) 5% = ______
   (2) 20% = ______
4. Convert the following ratios to percentages:
   (1) 1:10 = ______
   (2) 1:25 = ______
5. Convert the following percentages to decimals:
   (1) 8% = ______
   (2) 87% = ______
   (3) 3% = ______
6. Convert the following decimals to percentages:
   (1) 0.08 = ______
   (2) 0.17 = ______
   (3) 0.98 = ______
7. Define the word **proportion.**
8. When a ratio is changed to a fraction, what does the first numeral become?
9. What is the rule for converting a fraction to a percentage?

B-5

The Metric System

Objectives: *After completing this assignment, you will be able to—*

1. *discuss the work problems using metric weights;*
2. *discuss and work problems using metric capacities; and*
3. *discuss and work problems using metric lengths.*

Introduction

In the eighteenth century, the French Academy of Science devised a system of measurement called the metric system. The basic unit of length, the meter, was to be one ten-millionth (1/10,000,000) of the distance from the equator to one of the poles of the earth. One meter equals 39.37 inches in the English system—a distance slightly more than 1 yard. To multiply or divide the meter, powers of 10 are used. Conversions in the metric system depend on changing the place of the decimal point. Study table 1 very carefully. It is the key to understanding the metric system.

The metric system is used to measure precise quantities of distance, capacity, weight, temperature, and pressure. The metric system is used in many countries. The **English system** is used in the United States, but many companies manufacture hand and machine tools in metric dimensions that can be repaired or adjusted only with metric wrenches. Finishing materials are sometimes packaged in metric weights or capacities.

Using the prefixes shown in table 1 with the three units (gram, liter, and meter), the following unit measurements can be derived:

Weight

Milligram:	1/1,000 of a gram (g) = 0.001 gram = 1 milligram (mg)
Centigram:	1/100 of a gram (g) = 0.01 gram = 1 centigram (cg)
Decigram:	1/10 of a gram (g) = 0.1 gram = 1 decigram (dg)
Dekagram:	10 grams = 1 dekagram (dkg)
Hectogram:	100 grams = 1 hectogram (hg)
Kilogram:	1,000 grams = 1 kilogram (kg)

Capacity

Milliliter:	1/1,000 of a liter (1) = 0.001 liter = 1 milliliter (ml)
Centiliter:	1/100 of a liter (1) = 0.01 liter = 1 centiliter (cl)
Deciliter:	1/10 of a liter (1) = 0.1 liter = 1 deciliter (dl)
Liter:	1/10 of a liter (1) = 0.18 dry pint or 0.21 liquid pint
Liter:	1 liter (1) = .908 dry quart or 1.057 liquid quarts

Table 1

Metric System Prefixes

Weight—gram		Capacity—liter		Length—meter	
Milli	0.001	Milli	0.001	Milli	0.001
Centi	0.010	Centi	0.010	Centi	0.010
Deci	0.100	Deci	0.100	Deci	0.100
Deka	10.000	Deka	10.000	Deka	10.000
Hecto	100.000	Hecto	100.000	Hecto	100.000
Kilo	1,000.000	Kilo	1,000.000	Kilo	1,000.000

Dekaliter: 10 liters = 1 dekaliter (dkl)
Hectoliter: 100 liters = 1 hectoliter (hl)
Kiloliter: 1,000 liters = 1 kiloliter (kl)

Length

Millimeter: 1/1,000 of a meter (m) = 0.001 meter = 1 millimeter (mm)
Centimeter: 1/100 of a meter (m) = 0.01 meter = 1 centimeter (cm)
Decimeter: 1/10 of a meter (m) = 0.1 meter = 1 decimeter (dm)
Dekameter: 10 meters = 1 dekameter (dkm)
Hectometer: 100 meters = 1 hectometer (hm)
Kilometer: 1,000 meters = 1 kilometer (km)

Weight

The unit weight in the metric system is the gram. The prefixes dealing with weights are in multiples of 10.

1,000 milligrams = 1 gram
1,000 grams = 1 kilogram
1 kilogram = 2.205 pounds
1 pound = 453.6 grams
1 ounce = 28.35 grams

Example: How many grams are in 3 ounces?
1 ounce = 28.35 grams
28.35 x 3 = 85.05 grams
Example: Convert 3 pounds to kilograms.
1 kilogram = 2.205 pounds
3 ÷ 2.205 = 1.36 kilograms

Capacity

The units of volume in the metric system are the liter (1) and the milliliter (ml).
1 liter = 1,000 milliliters
1 liter = 2.113 liquid pints or
1 liquid pint = 0.473 liter
1 liter = 1.057 liquid quarts or
1 liquid quart = 0.946 liters
1 liter = 0.264 liquid gallon or
1 liquid gallon = 3.785 liters
1 liter = 270.512 fluid drams or
1 fluid dram = 0.004 liter

Example: How many millimeters are in 2.6 liters?
1 liter = 1,000 milliliters
2.6 x 1,000 = 2,6000 milliliters
(This problem may also be worked by moving the decimal point three places to the right.)

Example: Convert 5 gallons to liters.
1 gallon = 3.785 liters
3.785 x 5 = 18.925 liters

Example: Convert 3,000 milliliters to liters.
1,000 milliliters = 1 liter
3,000 ÷ 1,000 = 3 liters
(This problem may also be worked by moving the decimal point three places to the left.)

Length

Length is the distance covered by a line between two points. Before 1960, the standard for the meter was a piece of metal kept at Sevres, France. This piece of metal had two scratches on it, and the distance between these scratches was defined as a meter. In 1960, the meter was redefined in terms of wavelengths.
1,000 meters (m) = 1 kilometer (km)
1,000 millimeters (mm) =
100 centimeters (cm) = 1 meter (m)
1 centimeter (cm) = 10 millimeters (mm)
1 inch = 2.54 centimeters (cm)
1 meter = 39.37 inches
1 kilometer = 0.6214 mile

Example: How many inches are in 5 meters?
1 meter = 39.37 inches
39.37 x 5 = 196.85 inches

Example: Convert 250 centimeters into meters.
1 meter = 100 centimeters
250 ÷ 100 = 2.5 meters
(This problem may also be worked by moving the decimal point two places to the left.)

Exercise

1. What is the relationship between the length of a meter and the Earth?

2. How many liters are in 270 milliliters?
3. Convert 12 pounds to kilograms.
4. Convert 3,600 meters to kilometers.
5. How many grams are in 1 ounce?
6. How many inches are in 1 meter?
7. How many quarts are in 1 liter?
8. Convert 5 gallons to liters.
9. What is the unit of weight in the metric system?
10. How many grams are in 9 ounces?

B-6

Developing Areas, Perimeters, and Circumferences

Objectives: *After completing this assignment, you will be able to—*

1. *work problems to determine the area of squares and rectangles;*
2. *work problems to determine the perimeter of squares and rectangles; and*
3. *work problems to determine the area and circumference of circles.*

Area of a Square

Bricklayers and stonemasons work with various shapes and dimensions. It is often necessary to find areas, perimeters, and circumferences so that walls, patios, or walks can be laid out for construction.

Areas are determined by units of square measure. Areas are usually calculated by multiplying length and width together. In cases where the length and width are given in inches, the area is shown in **square inches.** When the length and width are given in feet, the area is shown in **square feet.**

A square is a plane figure having four equal sides and four square or right-angle corners. Since the length and width are the same, the area is equal to the square of one side ($A = s^2$).

Example: Find the area of a square when one side measures 7 feet.

$A = s^2$

$A = (7)^2$

$A = 7 \times 7$

$A = 49$ square feet

Area of a Rectangle

The area of a rectangle is found by multiplying the width by the length ($A = w \times l$). Both measurements should be in inches or feet before figuring area.

Example: Find the area of a rectangle 6 feet wide and 9 feet long.

$A = w \times l$

$w = 6$ feet

$l = 9$ feet

$A = 6 \times 9$

$A = 54$ square feet

Perimeter of a Square

The perimeter of a square is the distance around a square. You can add the four sides together to find the perimeter. Or, you can multiply one side by 4 ($P = 4 \times s$), since all sides of a square are the same length.

Example: Find the perimeter of a square when one side is 9 feet long.

$P = 4 \times s$

$s = 9$ feet

$P = 4 \times 9$

$P = 36$ feet

Perimeter of a Rectangle

A rectangle is a figure with two sides of equal length and two sides of equal width. To find the perimeter, or the distance around a rectangle, add the width and the length together, and multiply by 2 $[P = 2(w + l)]$.

Example: Find the perimeter of a rectangle with a length of 11 feet and a width of 7 feet.

$P = 2(w + l)$

$w = 7$ feet

$l = 11$ feet

$P = 2(7 + 11)$

$P = 2(18)$

$P = 36$ feet

Circumference of a Circle

The circumference of a circle (the distance around it) is always found by multiplying the diameter of the circle by 3.1416, known as pi (π). Many people shorten this figure to 3.14. This is not quite as accurate, but is usually permissible. The diameter is twice the radius. So, if you know the radius, simply multiply it by 2 to get the diameter ($d = 2r$).

Example: Find the circumference of a circle with a radius of 4 feet.

$C = \pi d$

$d = 2r$

$r = 4$ feet

$d = 8$ feet

$C = \pi(8)$

$C = 3.1416(8)$

$C = 25.1328$ feet

To find the number of inches, multiply the decimal part (.1328) by 12 inches, which gives 1.5936 inches.

Accuracy is important in masonry. For example, you may need to reduce the decimal part of an inch to thirty-seconds of an inch. In this case, you would multiply .5936 by 32. This gives 18.9952, which rounds off to 19 whole thirty-seconds. You would add the fractional part for an answer of 25 feet 1 19/32 inches.

Area of a Circle

To find the area of a circle, multiply pi times the radius squared ($A = \pi r^2$). Remember that the radius is one-half of the diameter ($r = 1/2d$).

Example: Find the area of a circle with a 12-foot diameter.

$A = \pi r^2$

$d = 12$ feet

$r = 6$ feet

$A = \pi(6)^2$

$A = (3.1416) \times (6 \times 6)$

$A = (3.1416) \times 36$

$A = 113.0976$ square feet

The decimal part of .0976 can be reduced to square inches by multiplying it by 144 (the number of square inches in a square foot). This gives 14.0544 square inches. The answer would then be 113 square feet and 14 square inches.

Exercise

1. What is the floor area of a patio 12 feet by 12 feet?
2. How many square feet of walk space are there on a walk measuring 4 feet by 20 feet?
3. Find the area of a rectangle 9 feet wide and 17 feet long.
4. How many square feet are in a room that is 15 feet wide and 36 feet long?
5. What is the area of a circular patio with a 15-foot diameter?
6. What is the perimeter of a rectangle that is 9 feet wide and 14 feet long?
7. What is the perimeter of a square that is 20 feet long on one side?
8. Find the circumference of a circle having a diameter of 16 feet.
9. Find the area of a circle having a diameter of 8 feet.

C-1

General Safety

Objectives: *After completing this assignment, you will be able to—*

1. *list general requirements for good housekeeping;*
2. *discuss personal protective devices to use in masonry trades; and*
3. *describe safety measures to use when using ladders and scaffolds.*

Good Housekeeping

Good housekeeping on a job means the orderly placement and storage of tools and materials. Housekeeping rules also serve as safety measures because loose articles and litter may cause you or another worker to stumble or fall and suffer an injury. Common sense can prevent accidents as well as damage to materials and equipment.

Always keep the work space clear and safe for all persons in the area. Place tools and materials where they cannot fall and where no one is likely to stumble over them. When material must be piled, make the pile neat and compact. Never lean tools or materials where they could be jarred loose or against a wall or other support that could collapse under the additional weight.

Personal Protective Devices

Whether you are working with brick or stone, there are hazards that can be avoided by wearing protective clothing or devices.

Inhalation and skin exposure. Masons work with acid when cleaning brick and stone. This presents a potential threat to the health of workers. All organic solvents have some effect on the central nervous system and the skin. The principal types of exposure are vapor inhalation and skin contact. The inhalation of acid fumes may result in serious damage to the blood, lungs, kidneys, and gastrointestinal system. Skin contact may cause skin inflammation, ranging in severity from minor irritation to serious damage to the skin.

Dangers also exist when working in air contaminated with other dusts or fumes. Be sure that you have a NIOSH-approved respirator that is designed to protect against the specific hazards to which you will be exposed. Always clean the respirator at the end of each day's use. Replace defective parts and used filters. Never use another person's respirator unless it has been cleaned and disinfected. Be sure that the respirator has a good seal on the face. If you smell vapors during use, immediately check the seal, the filter, and the cartridge, and replace if needed.

Noise exposure. Excessive noise is a common problem when working around power equipment such as a masonry saw. Noise can cause permanent hearing damage. Be sure that you are not exposed to noise levels in excess of the standards that have been set up by the National Institute for Occupational Safety and Health (NIOSH). The current standard is 90 decibels, A-weighted (dBA), for an 8-hour exposure. Even at this noise level, hearing damage can be expected in some people. You should periodically have your hearing checked. There are several types of ear protection devices, from ear muffs to ear plugs. Some are better than others, depending upon the type and frequency of the noise they are designed for, and how well they fit the individual.

Eye protection. Eye protection is needed where there is a possibility of an eye injury from flying particles, chips, and caustic materials. You should wear goggles or face shields when using grinders, power drills, masonry saws, and other power equipment.

Protective clothing. When handling hazardous liquids or sharp materials, you should wear gloves. Rubber gloves should be worn when working with acids. They should be long enough to protect the forearms. Hard hats should be worn around most masonry jobs, since materials or tools could fall from walls or scaffolds. Hard-toed shoes should also be worn to protect the feet from falling objects.

Ladders and Scaffolds

Ladders are either fixed or portable. Portable ladders are the single-unit, stepladder, or extension type. Most ladders are either metal or wood, although some very expensive ones are made of fiberglass. They should be kept in good condition at all times, and should be coated with a suitable protective material. Wooden ladders should have a transparent coating so you can see any cracks or flaws that might develop. All ladders should be inspected often. Wooden ladders should be stored where they will not be exposed to the weather, and where there is good ventilation. Metal ladders should not be used near energized electrical equipment. Never place portable ladders on boxes, barrels, or other unstable bases. Use a nonslip base instead.

When setting up long, straight, or extension ladders, brace the lower end of the ladder against something solid so that it cannot slide. Place the ladder at the correct angle with the wall. The base of the ladder should be one fourth of its working length away from the wall or support. If the ladder is placed at too great an angle (with the base too far out), the stress can cause it to break or slip. If the base is too close to the wall, the ladder may tip backward. Be sure that the ladder has a firm footing before you climb it.

Never climb higher than the step below the top of a stepladder. If you stand on the top, you may lose your balance. Go up and down a ladder carefully, always facing the ladder. Carry tools or other work materials in your clothing or attached to a belt. Never overreach or lean to the side of the ladder.

Only standard scaffolds suitable to the work at hand should be used. Makeshift substitutes should be avoided. Each scaffold should be maintained in a safe condition, and no scaffold should be altered or disturbed while in use. Structural members, supportive lines and tackles, and other scaffold equipment should be inspected daily.

Scaffolds should be kept free of tools, equipment, and materials not being used. Unstable objects, such as barrels, boxes, loose bricks, and building blocks, should not be used to support scaffold planks. Lines should be used for raising and lowering tools and materials that cannot be passed from hand to hand. No objects should be thrown or dropped from scaffolds. If part of a scaffold must be used for loading or supporting materials, it should have additional bracing and reinforcing in and around the area. Never overload a scaffold with masonry materials.

Work on scaffolds should be stopped during storms or high winds, or when scaffolds are covered with ice or snow. When scaffolding is dismantled, it should be cleaned and made ready for reuse or storage. Damaged or unsafe scaffolding should never be stored, as it might be accidentally used.

Exercise

1. What are the dangers of leaning tools or material against walls or other supports?
2. What cleaning agent may cause a health threat to masonry workers?

3. What may inhalation of acid fumes cause?
4. What else should you avoid when working with acid?
5. What should be worn when working around dusts or fumes?
6. What should you check if you are wearing a protector against harmful inhalation, but still smell the vapors?
7. What may cause hearing damage?
8. What does the type of hearing protection device used depend on?
9. When should eye protection devices be used?
10. What two types of eye protection devices may be worn?
11. What should be worn for protection from tools or materials that might fall from walls or scaffolds?
12. Why should wooden ladders be coated with transparent coating?
13. When should metal ladders not be used?
14. How far should a straight or extension ladder be from the wall on which it is leaning?
15. What direction should you face when going up or down a ladder?
16. When should work be stopped on scaffolds?

C-2

Handling and Storage

Objectives: After completing this assignment, you will be able to—

1. explain the precautions to take when handling materials by hand;
2. list the steps for proper lifting; and
3. discuss the methods of storing tools and materials.

Handling Materials by Hand

Surveys indicate that a majority of industrial accidents occur while materials are being handled. Handling materials by hand seems to produce more accidents than handling by mechanical equipment, although the damage and injury is not as severe. Nevertheless, people cause the majority of accidents.

All workers who handle materials should wear approved safety shoes. Foot and leg guards should be worn when handling heavy or sharp material that is likely to cause damage if dropped.

Workers should wear gloves when carrying, lifting, or moving objects that are sharp, splintery, or hazardous to bare hands. Workers handling acids should wear suitable approved clothing. Rings should never be worn by anyone handling materials. Fingers caught between heavy objects may be bruised, but if rings are present serious cuts or amputations may result.

Lifting Heavy Objects

In masonry work, lifting heavy weights is usually necessary. The following suggestions are made to preserve the health of masonry workers. See figure 1 for proper lifting position.

1. Check the weight of the load before lifting. Do not lift an excessively heavy load. Get help if necessary.

2. In general, lift loads no heavier than about 35 percent of the lifter's body weight.

3. Lift with the legs and not the back.

4. Keep feet close to the object being lifted, with one foot slightly closer than the other for better balance.

5. Stand with the feet approximately 8 to 12 inches apart.

6. To lift something heavy, assume a squatting position with the back erect and then raise the object by straightening the legs. This method will bring the leg muscles into use and take the strain off the back.

7. When two or more people are working together, lifting and lowering must be done at a given signal in order to equalize the load. The entire body should always be pushed upward with the legs — it is easier and safer.

Storing Materials

Piling and stacking should be done in a stable and secure manner, so that materials may be easily reached or moved. Only authorized persons should be permitted in storage areas. Arrangements should be made for disposal of surplus or damaged materials and waste. Store acid in glass containers in low locations, such as bottom shelves. This lessens the possibility of breakage from falls.

All hand and power tools should be stored in dry locations when they are not in use. If power equipment is left at the building site at night, it should be covered with rain-proof material. Mortar and other materials affected by moisture should also be covered.

Exercise

1. When do a majority of industrial accidents happen?
2. When should foot and leg guards be worn?
3. What are used in hand-lifting operations?
4. When two or more people are working together, when must lifting and lowering be done?
5. Who should be permitted in storage areas?
6. When should gloves be worn?
7. What should never be worn by anyone handling materials?
8. What position should be assumed to make a heavy lift?
9. Where should acid be stored?

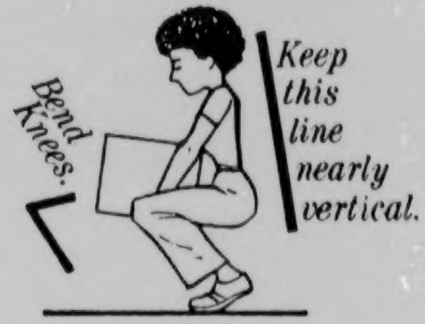

Bend Knees.
Keep this line nearly vertical.

Figure 1. Lift Properly

C-3

Hand and Power Tool Safety

Objectives: After completing this assignment, you will be able to—

1. list precautions to take when using sharp-pointed hand tools;
2. discuss saw and blade safety;
3. describe safety to observe when using pounding tools; and
4. give safety rules concerning power equipment.

Hand Tools

Sharp-pointed tools. Although hand tools do not usually cause severe injuries, the greater number of industrial accidents occur during their use. Keep in mind that all cutting tools should be kept sharp, as forcing a dull cutting tool often causes accidents. Hand tools should not be carried on the person unless they are encased in a sheath or tool belt. Do not place these tools on surfaces where a worker could bump into them or knock them off.

Saws and chisels. These tools cause more accidents than most other hand tools. Chisels often have sharp cutting blades; therefore touching them may cause a serious cut. Hand saws are sometimes used by the masonry worker. Always store saws and chisels with the blades down and cover all saw teeth when the tool is not in use. Use special care when sharpening saws and chisels.

Pounding tools. The mason may receive injuries in two ways when using pounding tools. Injury may result from missing a chisel head and hitting a finger or hand. Bruises, blood blisters, and torn flesh may occur from a hard, incorrectly placed blow. The hammer head should be flat, dry, and slightly rough to keep it from slipping off the chisel head.

Injury may also occur from pounding a chisel that has a mushroomed top, one that has been pounded until the top has spread and split around the edges. A hard blow may cause these metal particles to release and be thrown into the face or eyes. See that the top of the chisel is ground off before hammering on it. Also, wear goggles or a face shield when doing this type of work, and protect the eyes from flying rock or brick particles during chiseling operations.

Power Tool Safety

Masonry cutters. These cutters are very sharp and can cause serious injury or loss of fingers. Keep the fingers away from the blade during stone-splitting operations. Special care should be taken when removing, replacing, and sharpening these blades. Use leather gloves when possible.

Masonry saws. These saws are dangerous in several ways. The speed of the blade can cause materials to be thrown from the saw. Wear goggles or a face mask while sawing. A lot of dust is generated when cutting masonry materials, so it is also wise to use a respirator. Forcing the saw may cause the blade to break, so be sure guards are in place before making a cut. Use care when removing or replacing saw blades and take the usual precautions when sharpening a blade.

Cement mixers. Cement mixers are normally used to mix mortar for brick or stone. This device is often top-heavy when it is full and therefore should be on level ground and in a stable position. If it tips over, the weight could cause a great amount of damage or injury. If large cement mixers are used, make sure that all troughs are in place during a "pour." Use loaded wheelbarrows with care, as a loaded wheelbarrow is hard to control on slopes or when trying to stop.

Exercise

1. How should sharp-pointed tools be carried on the person?
2. Why should all cutting tools be kept sharp?
3. What two ways do injuries occur when using pounding tools?
4. In what condition should the hammer head be?
5. What should be worn when using pounding tools?
6. When should special care be taken around masonry cutters?
7. What should be worn other than a face mask or goggles when operating a masonry saw?
8. What care should be taken when mixing mortar?
9. Why should a loaded wheelbarrow be used with care?

D-1

Reading Blueprints

***Objectives:** After completing this assignment, you will be able to—*

1. *discuss and draw conventional lines that are found on blueprints;*
2. *identify the symbols the bricklayer and stonemason must recognize; and*
3. *discuss details, sections, and schedules.*

Before you can successfully do any masonry work, you must know what the architect, contractor, or homeowner desires. To do this, you must be able to read blueprints. Blueprints tell what type of masonry materials to use, what type of reinforcement is needed, the dimensions of the structures, and where masonry is to be located. You should be able to look at a blueprint and know immediately what is expected.

Conventional Lines

When checking a blueprint, you will discover that the drafter uses many types of lines to give you information. Line characteristics — such as width, zigzags, line breaks, and curves — give you important information. The various kinds of conventional lines appear in figure 1.

Center lines. These lines are made up of long and short dashes. Long dashes appear at each end and alternate with short dashes, evenly spaced, along the entire length of the centerline. Centerlines extend about 1/4 inch past the outside of the object. Where centerlines intersect, small dashes overlap. These crossed lines locate the center of the object.

Visible lines. Visible lines are solid, thick lines. Visible lines indicate the outside borders of the object drawn. These lines are also used to define edges or lines that are visible within the object.

Hidden lines. Hidden lines are thin, short dashes. The hidden line begins with a dash that is in contact with the starting line unless an unbroken line is being continued.

Extension lines. Extension lines are thin and unbroken and begin about 1/16 inch from the object outline. These lines extend about 1/8 inch further than the outside dimension line, so that dimensions may be read easily. They are parallel to each other and at 90-degree angles to the distance that is shown. Where extension lines cross each other, they are broken.

Dimension lines. Dimension lines are thin and unbroken to allow for the insertion of dimension numbers. They are used between extension lines to indicate distances on a drawing. An arrowhead usually appears on each end of a dimension line to indicate where the distance begins and ends. When the radius of an arc is dimensioned, an arrowhead appears only at the end of the line that touches the arc. The end without an arrow stops at the location used as the center of the arc.

Leaders. A leader is a thin line that angles and ends in either an arrowhead or a dot at the drawing detail. Leaders are used on drawings to identify numbers, notes, or references with a particular line, opening, or detail. A short line extends from the identification parallel to the numbers or letters.

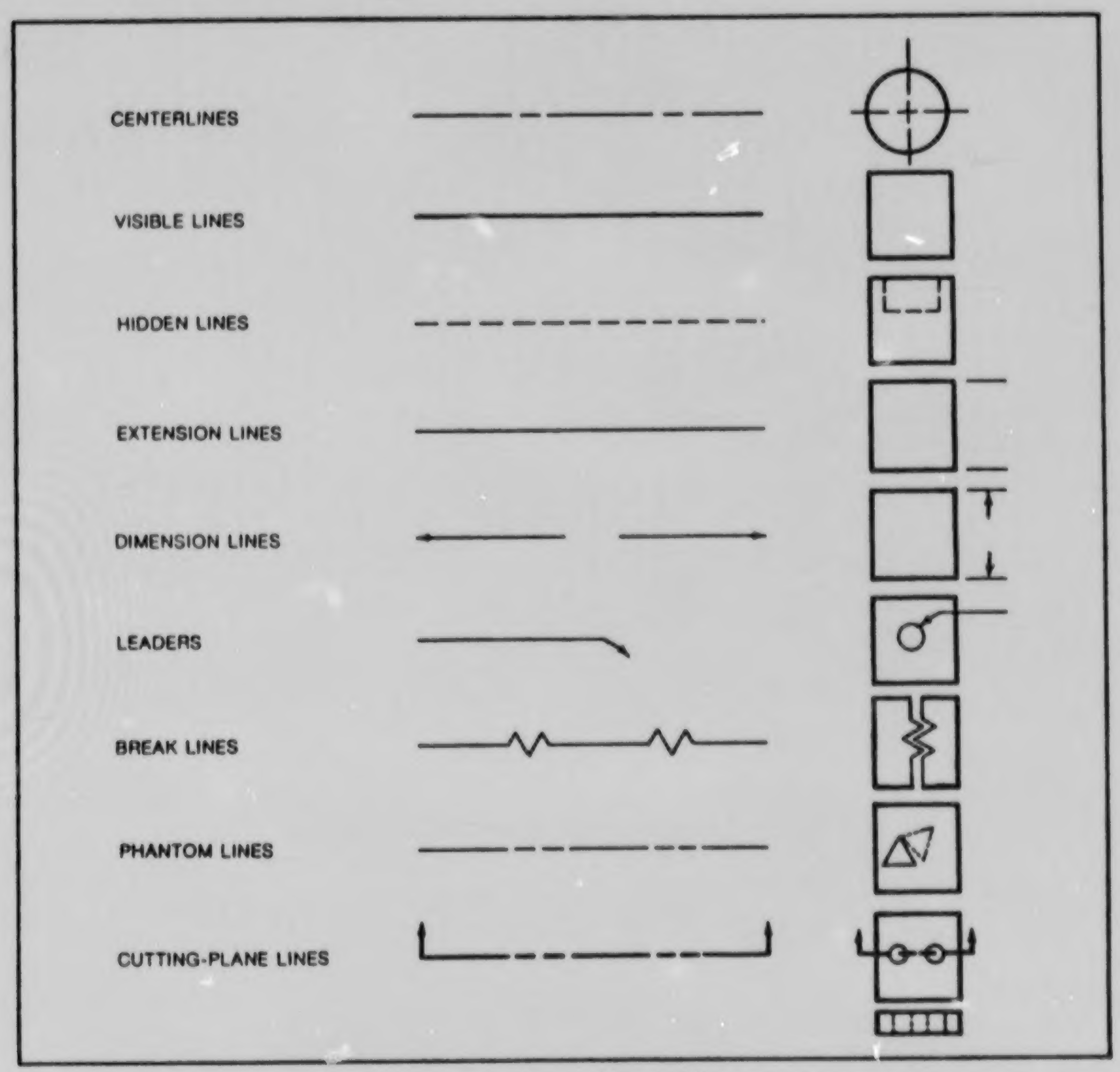

CENTERLINES
VISIBLE LINES
HIDDEN LINES
EXTENSION LINES
DIMENSION LINES
LEADERS
BREAK LINES
PHANTOM LINES
CUTTING-PLANE LINES

Figure 1. Conventional Lines

Break lines. Short break lines are shown with thick, wavy freehand lines, and long break lines are shown with thin, zigzag lines. These are used to save drawing space and shorten the length of a drawing when a long object has a continuous shape and size throughout its entire length. Sometimes, the drawing of a chimney or the length of a wall is shortened by this means.

Phantom lines. These long and short dashes are used to show positions or paths of movable objects or parts. This is important if the swing of one part interferes with another part that is either movable or stationary. An example would be phantom lines on a drawing to show the path in which a damper in a fireplace will swing when it opens.

Cutting-plane lines. Cutting-plane lines are thick, long and short dashes that angle and end in arrows. These lines indicate openings or parts that do not show from the outside of the object, and expose them to view. Even though hidden lines could be used, too many lines sometimes obscure the parts that should be shown. The arrows on the ends of cutting-plane lines show from which direction the sections are being viewed.

Symbols. Symbols are used when there is not enough room on the drawing to show a complete object. They give definite meaning for a number of items. Although it is important to be able to recognize electricity, plumbing, and heating symbols, the most important symbols that the mason should know are those that show openings in walls and materials to use. Figure 2 shows various types of material symbols found in both plan and elevation views. Figure 3 shows symbols for some of the openings used in the construction field.

Details

Because floor plans are so small after they have been scaled down, it is impossible to draw in all of the details. For this reason, a sheet or sheets are added to the blueprints and drawn on a larger scale. Structures that are shown on these sheets include kitchen cabinets, stairways, fireplaces, and other built-ins. Those extra sheets also contain any dimensions that will be needed during construction.

Sections

Sections are drawings that show a cutaway of an object, a building, or a part of a building. These drawings allow you to see the true shape of an object and its relationship to other parts. Sometimes the only way you can see hidden parts is by looking at a sectional view. Sections are often made of walls, fireplaces, stairs, windows, and interior trim.

Schedules

Schedules are tables that give information about various units that may be factory-made and installed at the structure. They are usually found with the floor plans. By looking at the schedule, you can get the dimensions of the unit in question, then allow the space needed for its insert.

Exercise

1. What types of dashes make up centerlines?
2. What is the purpose of visible lines?
3. Why are dimension lines broken?
4. Why are leaders used on drawings?
5. What kind of line is used to shorten the length of a drawing?
6. What kind of line shows positions or paths of movable objects or parts?
7. Why is it necessary to use symbols on a blueprint?
8. What are the most important symbols for a masonry worker to be able to recognize?
9. How are small details shown on a blueprint?
10. What do sections show?
11. What does a section drawing allow you to see?
12. What information can you get from a schedule?

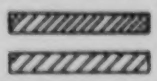
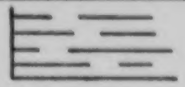
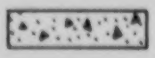
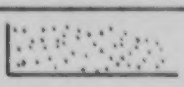
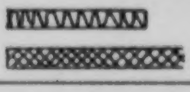
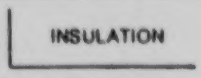
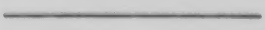
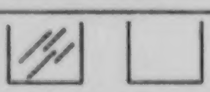
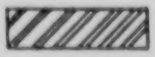
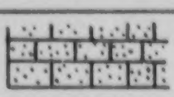
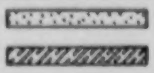
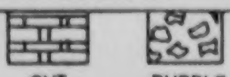
MATERIAL	PLAN	ELEVATION
BRICK	 FACE COMMON	
CONCRETE		
INSULATION		
GLASS		
CONCRETE BLOCK		
STONE	 CUT RUBBLE	 CUT RUBBLE

Figure 2. Materials Symbols

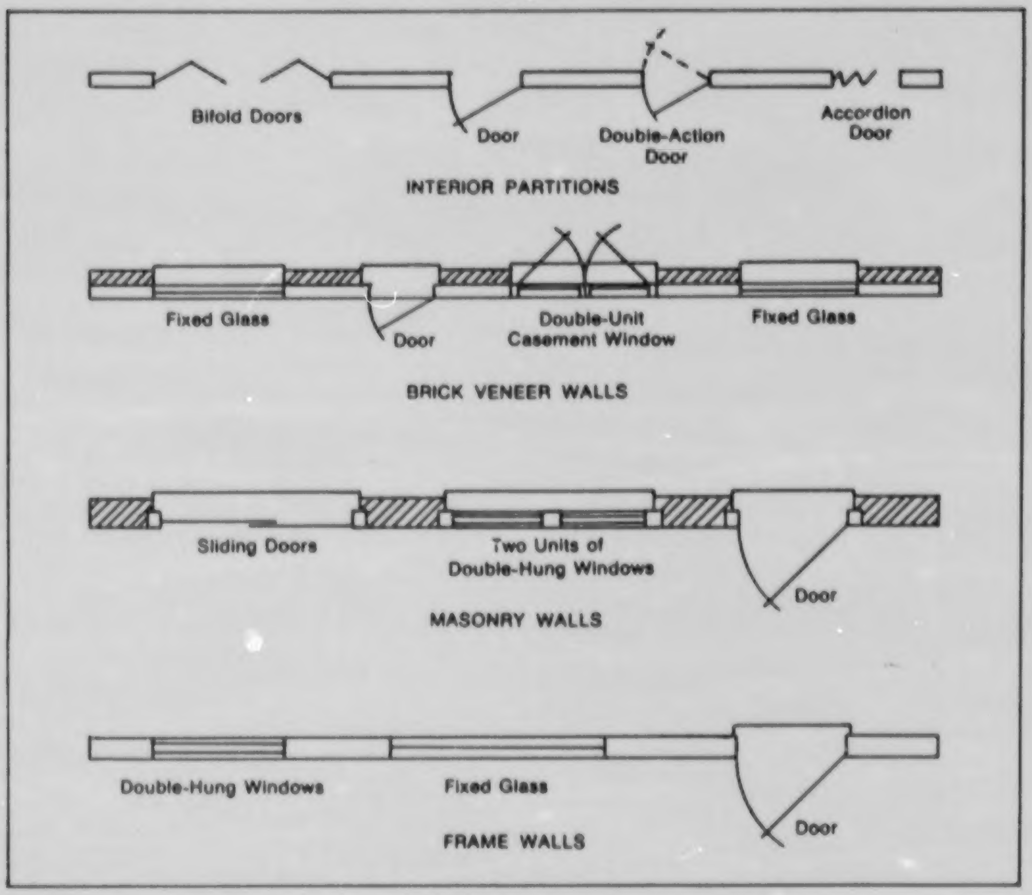

Bifold Doors
Door
Double-Action Door
Accordion Door
INTERIOR PARTITIONS
Fixed Glass
Door
Double-Unit Casement Window
Fixed Glass
BRICK VENEER WALLS
Sliding Doors
Two Units of Double-Hung Windows
Door
MASONRY WALLS
Double-Hung Windows
Fixed Glass
Door
FRAME WALLS

Figure 3. Wall Openings

D-2

Angles and Shapes

Objectives: *After completing this assignment, you will be able to—*

1. *recognize and discuss various types of lines and angles;*
2. *discuss various types of triangles, parallelograms, and polygons; and*
3. *describe prisms, cylinders, cones, and pyramids.*

Sometimes it may be necessary for you to draw various sketches before building specific structures or making designs of walks or patios.

Lines and Angles

Types of lines. **Horizontal lines** are usually drawn with a T square. They should always be drawn parallel with the top and bottom edges of the drawing paper.

Vertical lines are usually drawn with a triangle that is placed on the upper edge of a T square. A vertical line must be perpendicular, or at 90 degrees, to the horizontal line. The T square alone should never by used to draw vertical lines.

Bisecting and Dividing Lines. Many times you must know how to bisect lines. The steps in figure 1 show how this is done. The required length of the line AB is drawn first. If the line is horizontal, the T square is used. A pencil compass is then set to more than half of the distance between these points. Using A and B as centers, draw arcs that intersect at C and D. A line is then drawn from C to D. This line is perpendicular, or at 90 degrees, to line AB, and line AB has been bisected, or divided into two equal parts. Long arcs or parts of a circle may also be bisected in the same manner.

Types of angles. There are three types of angles (see fig. 2). The **acute angle** is less than 90 degrees, the **obtuse angle** is more than 90 degrees, and the **right angle** is drawn at 90 degrees, making the vertical line perpendicular to the horizontal line.

When the lines making up the angles are connected, they make a triangle. Figure 3 shows three types of triangles. The right triangle, like the right angle, has one angle drawn at 90 degrees. An isosceles triangle has two equal sides and two equal angles. An equilateral triangle has equal sides and equal angles.

Bisecting and dividing angles. At times the mason must bisect an angle, or divide it into two equal parts. To bisect an angle, draw lines AB and AC as shown in figure 4. Using a pencil compass and point A as a center, draw an arc across lines AB and AC, about halfway between the ends of the lines. Label the intersecting arc on the angle's lines D and E. Set the pencil compass wider than the distance between D and E, and, using D and E as centers, draw intersecting arcs to form point F. Draw a straight line from A to F, and you have bisected the angle.

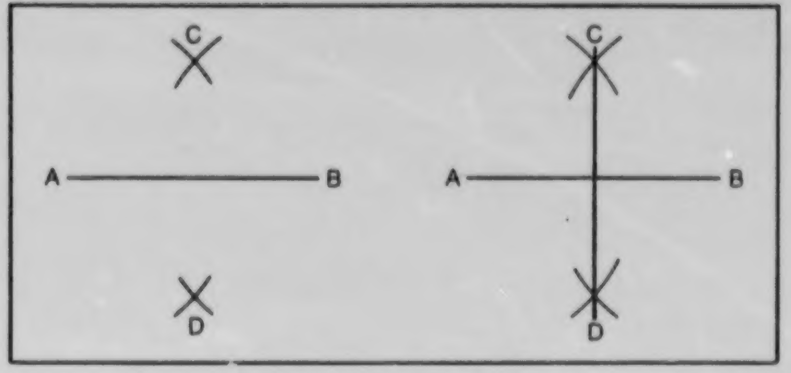


Figure 1. Bisecting a Line

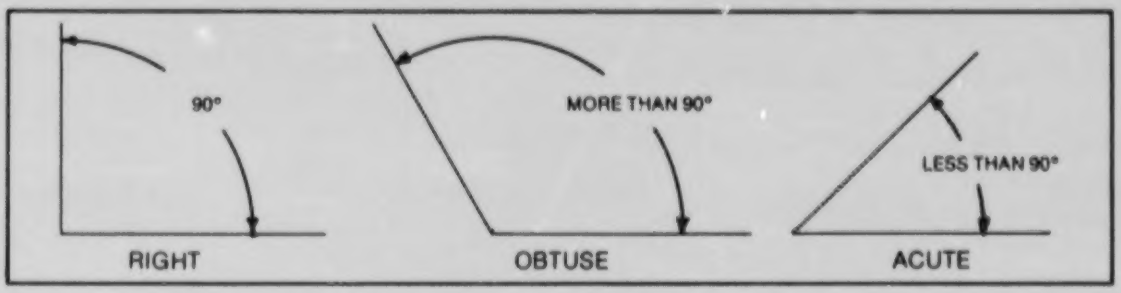

90°
MORE THAN 90°
LESS THAN 90°
RIGHT
OBTUSE
ACUTE

Figure 2. Types of Angles

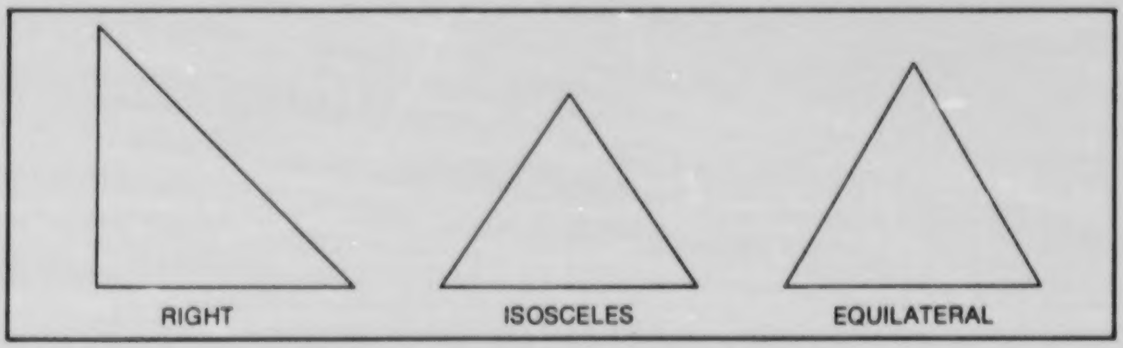

RIGHT
ISOSCELES
EQUILATERAL

Figure 3. Types of Triangles

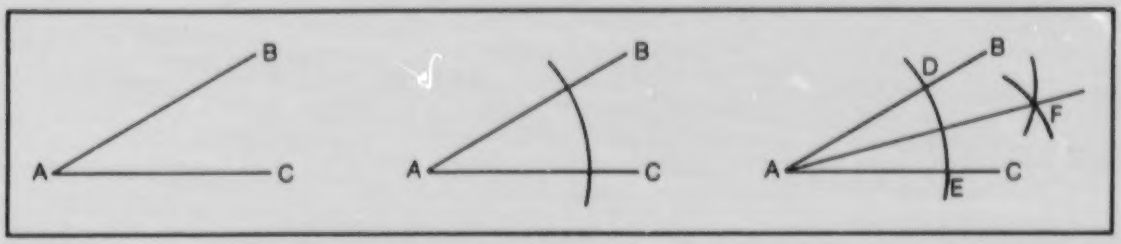

B
A
C
B
A
C
D
B
F
A
E
C

Figure 4. Bisecting an Angle

Circles and Ellipses

A circle is a curved line in which any point on the line is at an equal distance from the center. The parts of a circle are shown in figure 5. The **circumference** is the distance around a circle. The **diameter** is the distance from one side of the circle to the other, passing through the center. The **radius** is one-half the diameter — the distance from the center of the circle to the edge. A **chord** is a straight line that connects one edge of a circle to another. It does not have to cross the center, but the diameter can also be called a chord. A straight line touching the outside edge of a circle is called a **tangent**. Although not shown in figure 5, an **arc** is any part of the circle's edge.

A **circumscribed plane figure** is one that encloses another figure. An **inscribed figure** is one that is enclosed. For instance, if a triangle encloses a circle, the triangle is circumscribed, and the circle is inscribed. If the circle encloses the triangle, the circle is circumscribed and the triangle is inscribed. A true circumscribed figure must touch as many points of the enclosed figure as possible.

Figure 6 shows how to draw an **inscribed equilateral triangle** within a circle, thus circumscribing the circle. Draw a vertical centerline (diameter) through the circle, intersecting the circumference A and B. With B as a center, strike arcs the length of the radius of the circle, intersecting the circumference at E and F. The letters A, E, and F divide the circle into three equal arcs. Draw lines to connect A to E to F to A, thus forming an equilateral triangle.

Figure 7 illustrates how to circumscribe an equilateral triangle on a given circle, thus inscribing the circle. Draw AB parallel to the horizontal centerline, or diameter, of the circle and tangent to the circumference. Then use a straightedge and a sliding 30/60-degree triangle to draw AC and CB tangent to the circumference of the circle and at 60 degrees to AB.

Figure 8 shows a way to draw a square in a given circle, thus circumscribing the circle. Draw diameters AB and CD at right angles to each other, and connect the points where the diameters intercept the circumference of the circle.

A method for circumscribing a square on a given circle, thus inscribing the circle, is shown in figure 9. Draw diameters AB and CD at right angles to each other. Then draw one side of the square tangent to each point where the diameter intersects the circle's circumference. Draw each side perpendicular to the diameter.

Figure 10 shows how to draw a regular pentagon in a given circle, thus circumscribing the circle. Draw a horizontal diameter AB and a vertical diameter CD, perpendicular to each other. Locate E, the midpoint of radius OB. Set a compass to the spread between C and F, and, with C as a center, strike the arc GF. The straight line from G to C is one side of the pentagon. Set the compass to the length of GC, lay off this spread from C around the circle, and connect the points of intersection.

Figure 11 shows a radius method of drawing a regular hexagon when the circle to be circumscribed is given. The diameter of the circle to be circumscribed is the same length as the long diameter of the hexagon to be inscribed in the circle. The radius of the circle is equal in length to one-half the long diameter of the hexagon to be inscribed in the circle or any one side of the hexagon. Lay off the horizontal diameter AB of the circle; set a compass to one-half of this diameter, or OB. Lay off this spread all the way around the circle and connect the points of intersection with the circumference of the circle.

Figure 12 shows a method of drawing an octagon around a given circle, thus inscribing the circle. Draw the horizontal diameter AB and the vertical diameter CD perpendicular to each other. Draw lines perpendicular to AB and CD and tangent to the circle. Then use a T square and triangle to draw lines at 45 degrees to the horizontal line, tangent to the circle, and intersecting the perpendicular lines just drawn.

Parallelograms

Parallelograms are defined as figures whose opposite sides are parallel (see fig. 13). A **square** is a figure with four sides that are equal in length and all of whose corners form

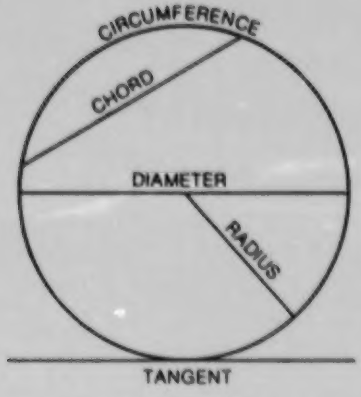

CIRCUMFERENCE
CHORD
DIAMETER
RADIUS
TANGENT

Figure 5. Parts of a Circle

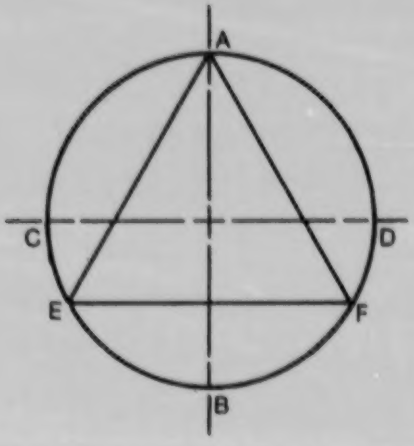


Figure 6. Equilateral Triangle within a Circumscribed Circle

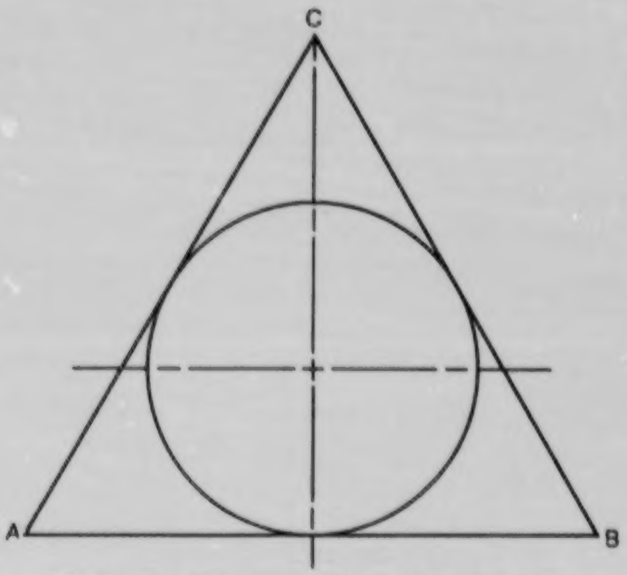


Figure 7. Circumscribing an Equilateral Triangle on a Circle

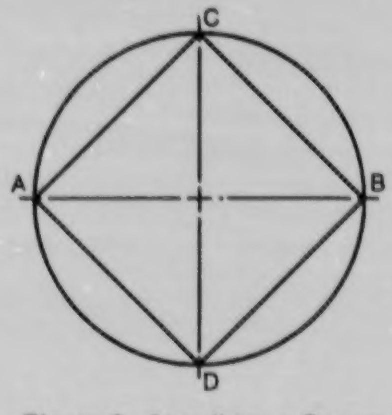


Figure 8. Inscribing a Square in a Circle

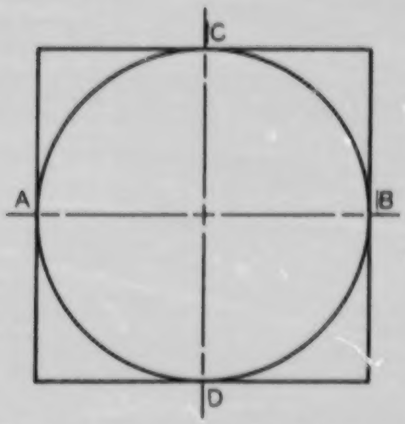


Figure 9. Circumscribing a Square on a Circle

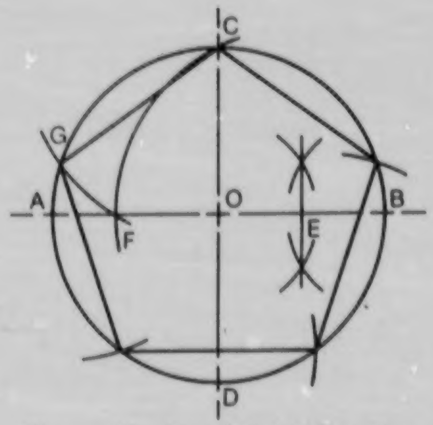


Figure 10. Inscribing a Regular Pentagon in a Circle

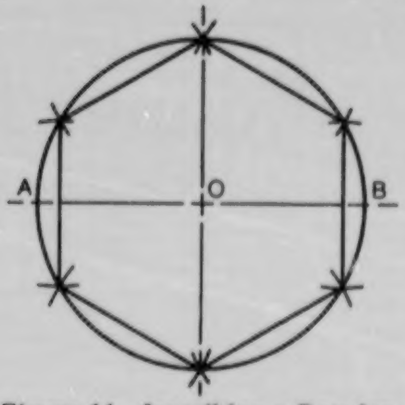


Figure 11. Inscribing a Regular Hexagon in a Circle

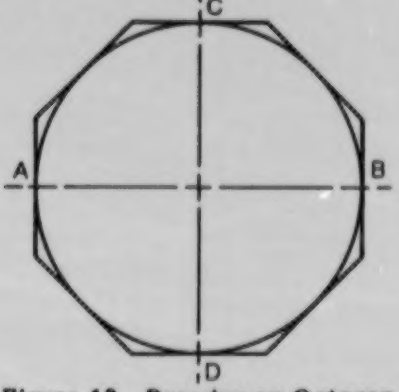


Figure 12. Drawing an Octagon around an Inscribed Circle

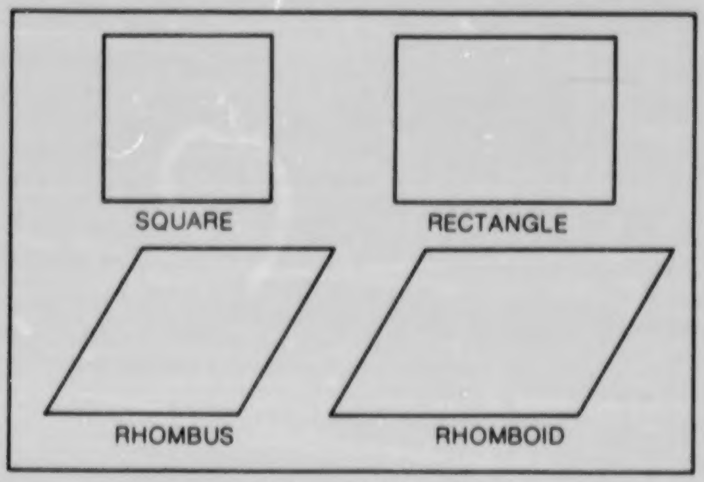

SQUARE
RECTANGLE
RHOMBUS
RHOMBOID

Figure 13. Types of Parallelograms

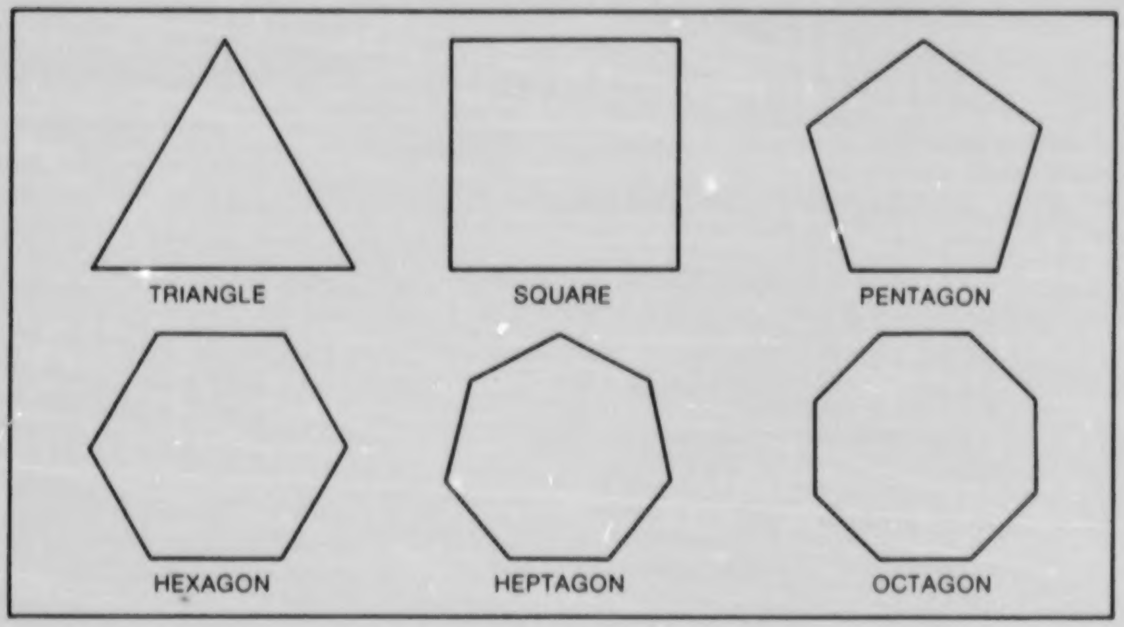

TRIANGLE
SQUARE
PENTAGON
HEXAGON
HEPTAGON
OCTAGON

Figure 14. Polygon Shapes

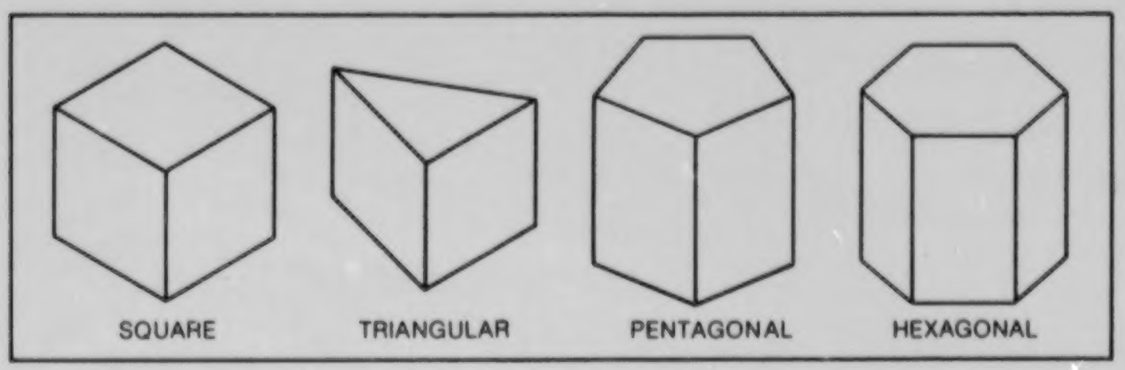

SQUARE
TRIANGULAR
PENTAGONAL
HEXAGONAL

Figure 15. Polygon Prisms

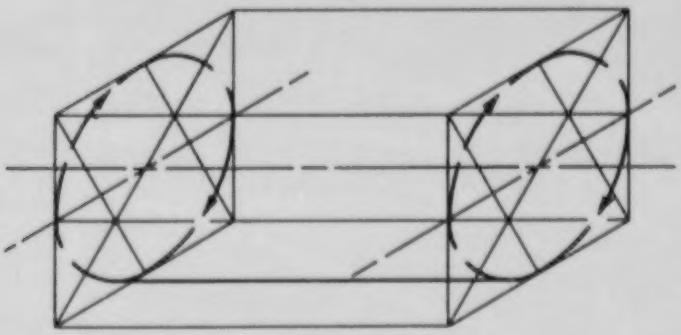


Figure 16. Forming a Cylinder

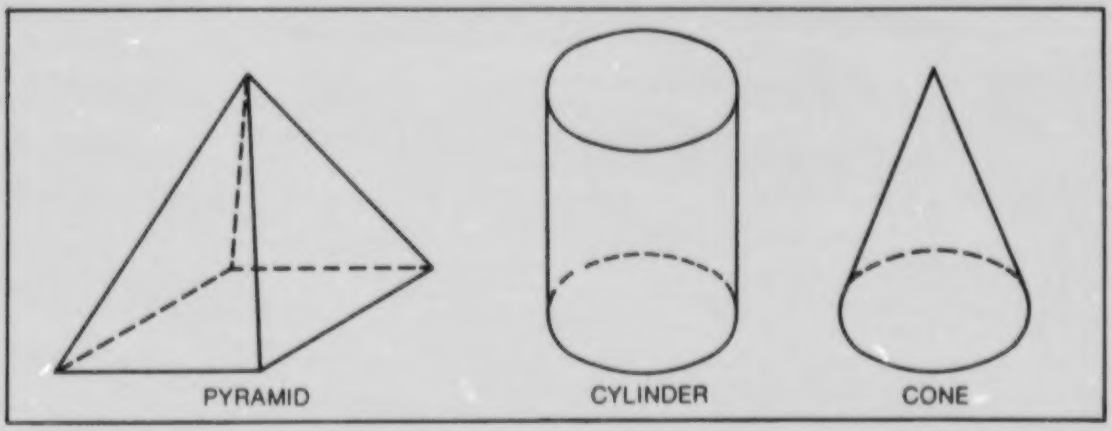

PYRAMID
CYLINDER
CONE

Figure 17. Types of Solids

90-degree angles. A **rectangle** is a figure with two sides of equal length, two ends of equal length but of different length from the sides, and all corners forming 90-degree angles. A **rhombus** is a figure with parallel sides the same length and with no 90-degree angles. The **rhomboid** is a figure with parallel sides of different lengths and with no 90-degree angles.

Polygons

A **polygon** (see fig. 14) is a figure with sides that are straight lines. If the sides are of equal lengths and the angles are equal, the shapes are known as regular polygons.

Types of Solids

Prisms. A **prism** is a figure with two bases that are parallel and the same size. The bases are classified as polygons, which may have several sides, as shown in figure 15. When the sides meet the base at an angle of 90 degrees, the prism is a right prism. When the sides meet the base at any other angle, the prism is known as an oblique prism.

Cylinders, Pyramids, and Cones. A **cylinder** is a figure that is formed when a straight line is moved in a circular motion, as shown in figure 16. An oblique cylinder is a cylinder that is tilted at an angle so that the axis is not perpendicular to the base.

Pyramids are drawn from polygon bases. The bases may be triangular, hexagonal, square, or other shapes. Faces are drawn as triangles that are constructed from each edge of the base upwards to a common point, which is called an apex. When the top of the pyramid is removed or cut off, it is known as a truncated pyramid. If the cut removing the top is at an angle, it is usually called a truncated angle.

Cones have circular bases with all sides projecting upward to a common point. Cones may also be truncated. Figure 17 shows the differences between cylinders, pyramids, and cones.

Exercise

1. What tool should be used to draw vertical lines?
2. Name the three types of angles.
3. Give the definition of an isosceles triangle.
4. When discussing a circle, what is a chord?
5. What is a circumscribed plane figure?
6. Define a parallelogram.
7. What is a rhomboid?
8. What is a right prism?
9. How is a cylinder formed?
10. From what type of base are pyramids drawn?

D-3

Types of Drawings

Objectives: *After completing this assignment, you will be able to—*

1. *identify and make working, isometric, and oblique drawings;*
2. *identify the various symbols and specifications contained in a floor plan; and*
3. *draw elevations and perspectives showing brick construction.*

Working Drawings

The simple working drawing (three-view or orthographic projection) is one of the most common drawings used by a mason. When making a working drawing, the object is taken apart mentally, and a sufficient number of views are made to show the exact size and shape of all sides (fig. 1). If you are building a wall with a number of offsets, your customer will quickly be able to see exactly how the finished project will look. Normally a working drawing contains three views — the top, front, and side or end. If the object is very complicated, more views may be needed. The views are generally arranged with the front view directly beneath the top view and the side view to the right of the front view (fig. 2). Enough space is left between the views for the dimensions to be shown.

Isometric Drawings

An isometric drawing shows the length, width, and height of an object in one view. It is made by revolving and tilting the object to be drawn to an angle so that the top, front, and side are all visible. Figure 3 shows a wall that is drawn in this manner. The lines are projected from the vertical at an angle of 30 degrees to the horizontal plane, and the receding lines are parallel. No distinction in size is between the dimension near the viewer and the dimensions farther away. Thus, the object in an isometric drawing may appear to be distorted even to the point of creating an optical illusion. It should be remembered, however, that lines that are parallel and of equal length on the object should be drawn parallel and of equal length on the isometric drawing. The object usually has to be scaled down, such as one inch equals one foot or at some other scale.

Oblique Drawings

In an oblique drawing (fig. 4), the front of an object may be shown without distortion, and the length and height of the object are true dimensions. This method of drawing is popular because irregularly shaped objects are more easily drawn than when the isometric method is used. It is usually better to place the largest dimension of the object at the front unless there is a need to show details that appear only on one side. The side or end may recede from the front at any angle, but you will find that a 45-degree angle is most convenient.

Perspective Drawings

A perspective drawing of an object is very similar to a photograph of that object. Perspective depends on the station point or ob-

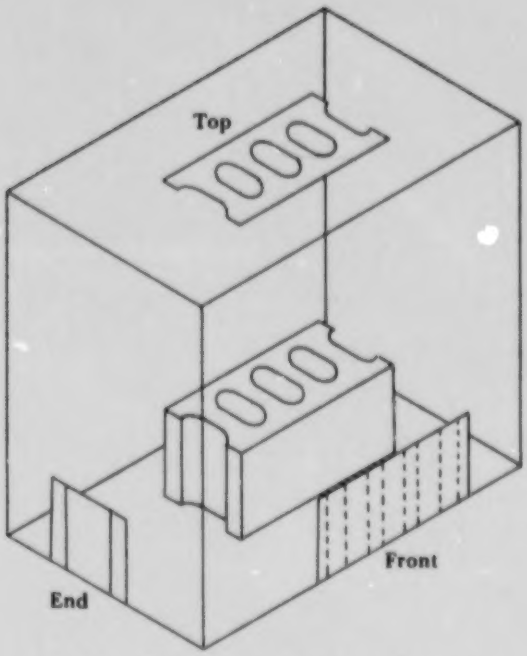

Top
Front
End

Figure 1. Relation of the Working Drawing Views to the Actual Object

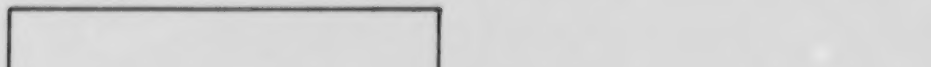


Figure 2. Working Drawing

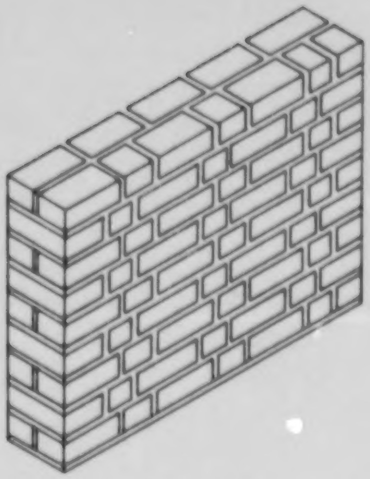


Figure 3. Isometric Drawing

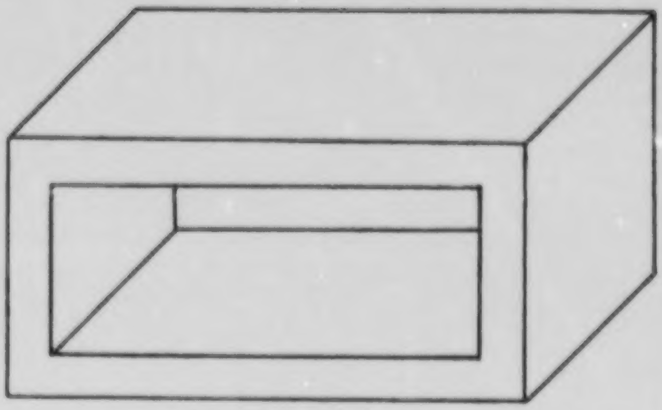


Figure 4. Oblique Drawing

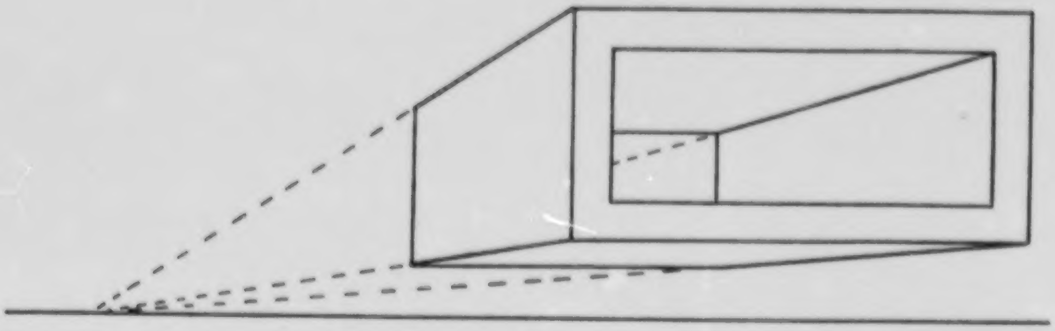


Figure 5. One-Point Perspective

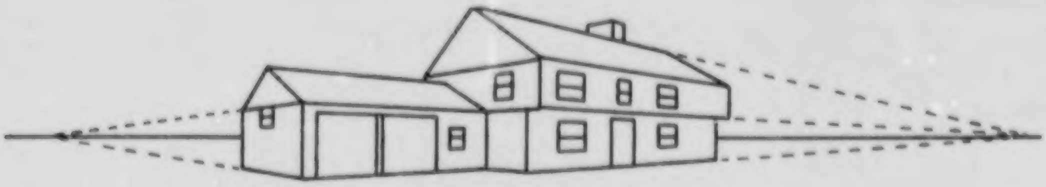


Figure 6. Two-Point Perspective

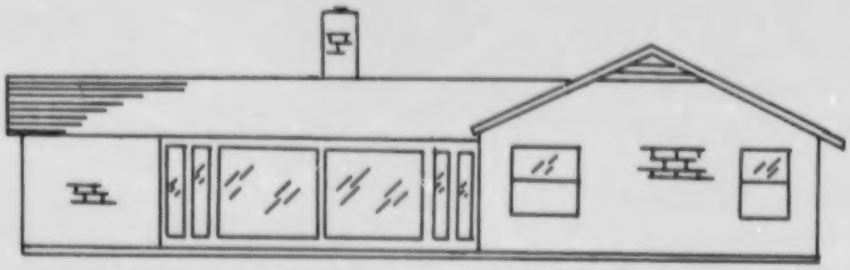


Figure 7. Front Elevation

servation point from which the object is viewed. For example, a person standing squarely in front of an object will see the object differently than a person standing to the side of the same object. While the angle of sight is different, the method of drawing is the same. Most perspective drawings are based on the idea that all lines seem to disappear at the horizon. The vanishing point of a one-point perspective could also be located to the left of the object at the horizon (fig. 5). A two-point perspective makes use of two vanishing points located at the horizon. Most house plans show the completed house drawn in two-point perspective (fig. 6). Not only is this type of drawing helpful to a prospective buyer of a home, but it also gives the mason an idea of wall arrangements where masonry work will be required.

Elevations

The elevation view of a structure (fig. 7) consists of a series of drawings that show the various sides as they would be seen by an individual standing directly in front of each side. These views show the doors, windows, and fireplace, as well as various widths and heights of all the parts that can be seen from the outside. After the elevation view has been drawn, symbols are used to show what materials are to be used at specific locations. Figure 8 illustrates the symbols for brick, siding, board and batten, stucco, cut stone, concrete, artificial stone, and concrete block.

Floor Plans

A floor plan is actually a bird's-eye view of the house or building that is to be constructed. The length and width of the walls and partitions, the size of the rooms, the locations of windows and doors, and the locations of certain built-ins are shown in this drawing, but the upper walls, ceilings, and roof are not illustrated. Symbols are placed throughout the floor plan in order to locate electrical outlets, plumbing fixtures, telephone jacks, and light switches. Floor plan symbols that may affect a mason's work are shown in figure 9. In order to show the whole structure, the walls may be scaled down to as small as 1/8 inch in width.

Exercise

1. What views are usually shown in a working drawing?
2. Where is the front view usually located in a working drawing?
3. Make a working drawing of a simple brick.
4. At what angle to the horizontal plane are lines projected in an isometric drawing?
5. Make an isometric drawing of a simple brick.
6. Which dimension in an oblique drawing is not distorted?
7. Make an oblique drawing of a simple brick.
8. What type of drawing is very similar to that taken by a camera?
9. What are two common types of perspective drawings?
10. What does an elevation view of a structure show?
11. Draw the symbol used to represent brick in an elevation view.
12. Draw the symbol used to represent glass block in a floor plan.

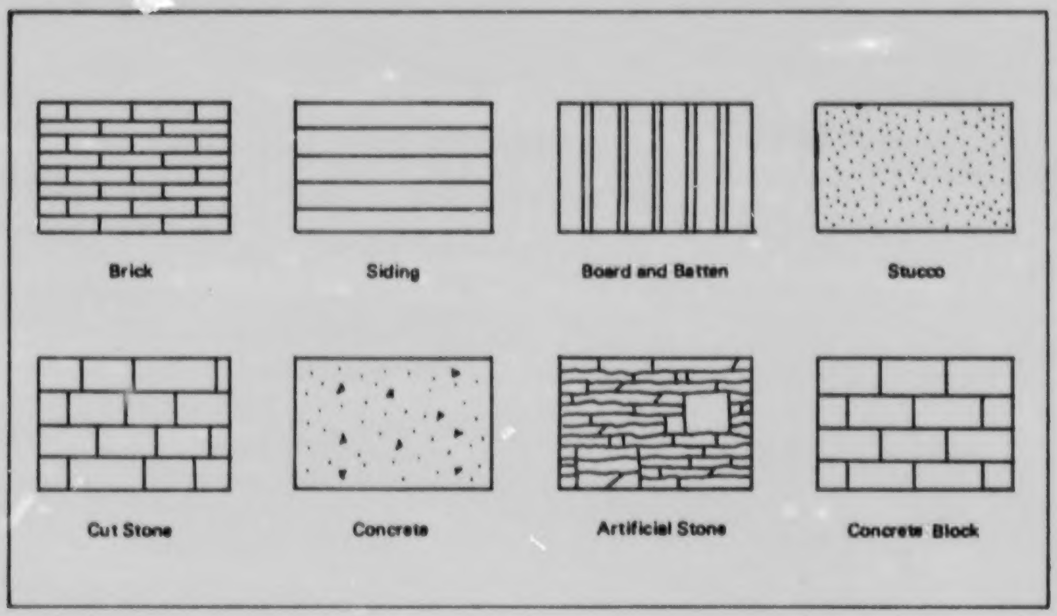

Brick
Siding
Board and Batten
Stucco
Cut Stone
Concrete
Artificial Stone
Concrete Block

Figure 8. Symbols for Elevation Views

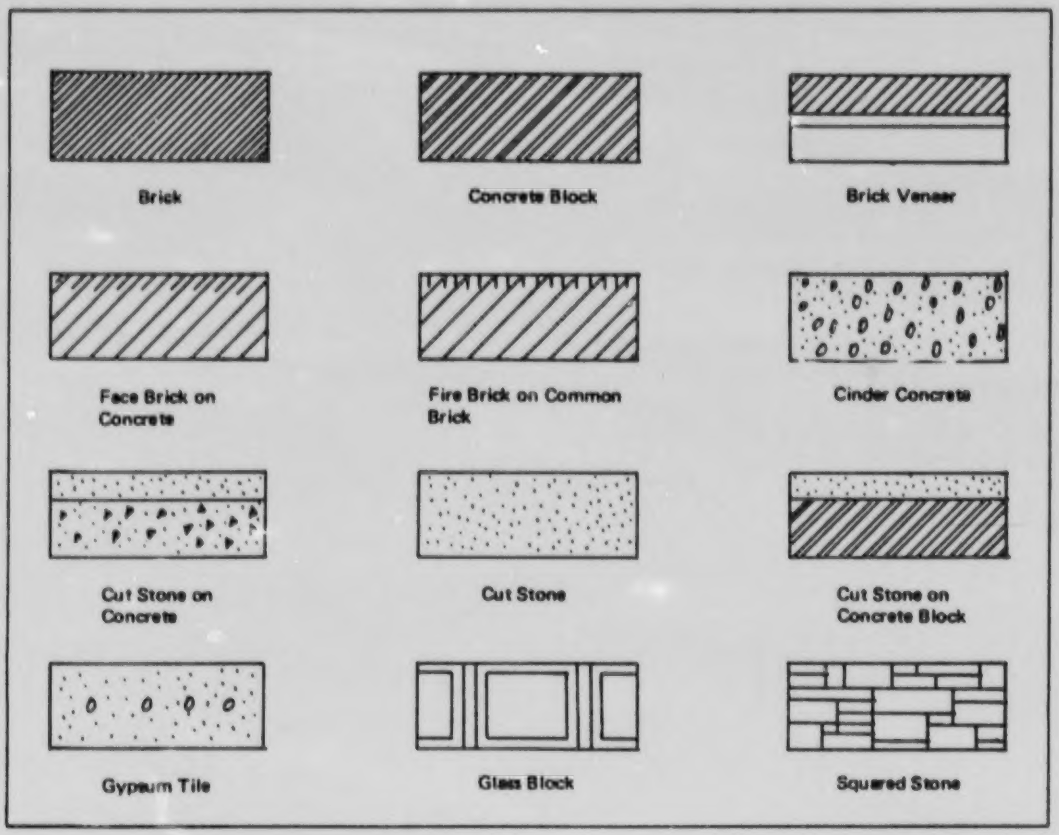

Brick
Concrete Block
Brick Veneer
Face Brick on Concrete
Fire Brick on Common Brick
Cinder Concrete
Cut Stone on Concrete
Cut Stone
Cut Stone on Concrete Block
Gypsum Tile
Glass Block
Squared Stone

Figure 9. Symbols for Floor Plan Views

E-1

Trowels, Hammers, and Chisels

***Objectives:* After completing this assignment, you will be able to—**

1. *identify and give the uses of various trowels;*
2. *identify and give the uses of masonry hammers; and*
3. *identify and give the uses of various types of masonry chisels and jointers.*

Types of Trowels

The trowel is the most important tool used by the masonry worker. Trowels are designed for handling small amounts of mortar and plaster. They are lightweight and well balanced for easy handling. Bricklayers and masons use brick trowels to pick up mortar and spread it on the wall or other construction unit in preparation for the next course (row) of brick, block, or stone. The blade and shank, or tang, are usually forged in one piece and the wooden handle is driven tightly onto the shank, or tang. The blade is usually taper-ground and polished, and the width at the heel is usually 5 to 5 1/2 inches. The Philadelphia pattern (fig. 1) is one of the most popular brick trowels. The trowel varies from 10 to 12 inches in length. The London pattern (fig. 2) has a rounded heel. This makes it possible for the mortar to be carried a little further forward on the blade. The length varies from 9 1/2 inches to 12 inches, and the width of the heel varies from 4 7/8 inches to 5 5/8 inches.

Cement trowels are used in finishing the surface of cement to the required smoothness. Troweling action helps compact the surface and adds to the quality and durability of the concrete. Cement trowels are narrower and longer than plastering trowels, and the blade is often slightly convex. The blade is usually about 4 inches wide and 12 to 18 inches long.

Using The Trowel

Speed and efficiency increase when you use as few movements as possible during the troweling operation. The beginner should start working with a small trowel until the wrist has been strengthened sufficiently for heavier work. The trowel should be held with the thumb and first finger on the handle near the heel and the thumb on the top of the handle. The other fingers encircle the back of the handle to give it more stabilization. The muscles of the hand and forearm must be kept relaxed so that the wrist will have flexibility of movement.

The mortar is picked up from the tub or board with the trowel, and sometimes it is necessary to cut or work the trowel into the mortar until a sufficient quantity has been picked up. Several bricks (four or five) should be laid end to end in a straight line on the practice wall. This should be about 2 feet away from the mortar tub or board. Pick up a small amount of mortar and try to spread it on the bricks that have been laid out. Keep the elbow away from the body; otherwise, it is very easy to bump the body and spill the contents of the trowel to the ground. This is time-consuming and wasteful.

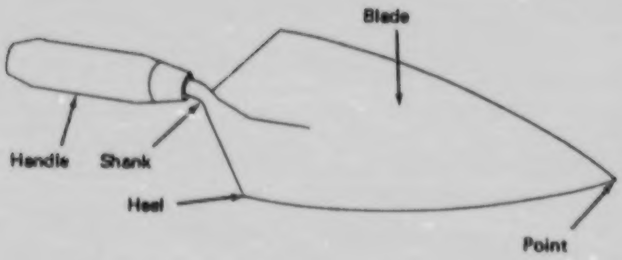

Blade
Handle
Shank
Heel
Point

Figure 1. Philadelphia Trowel

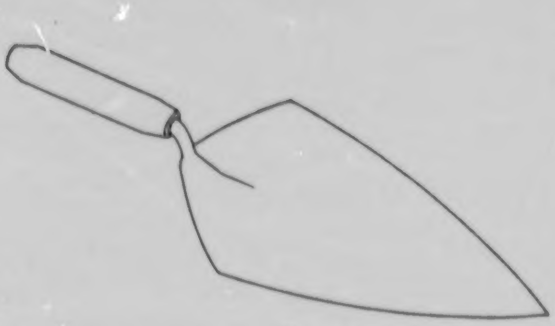


Figure 2. London Trowel

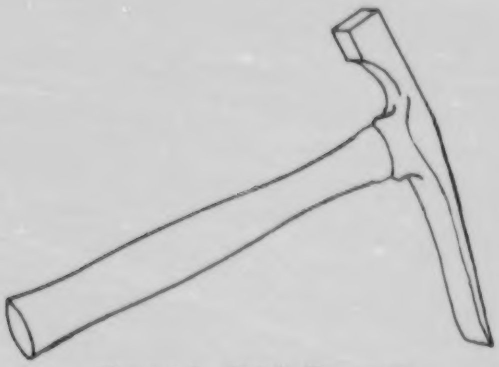


Figure 3. Brick Hammer

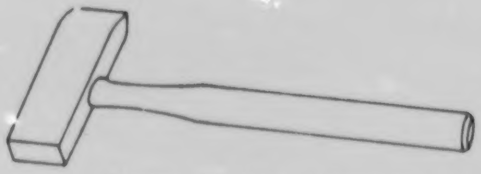


Figure 4. Stone Hammer

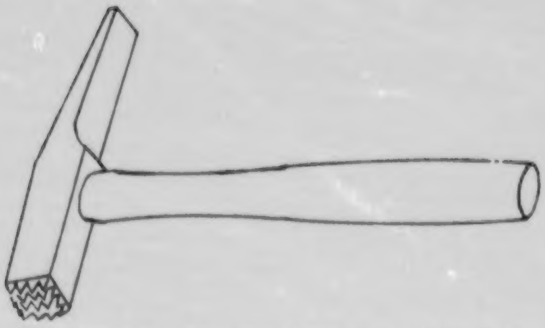


Figure 5. Toothed Concrete Hammer

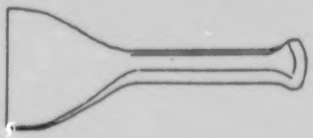


Figure 6. Brick Chisel

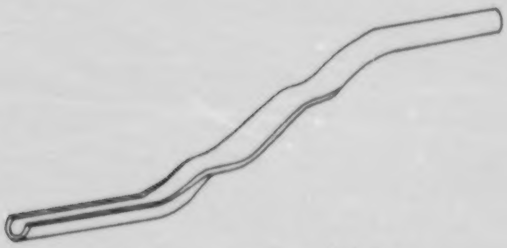


Figure 7. Convex Jointer

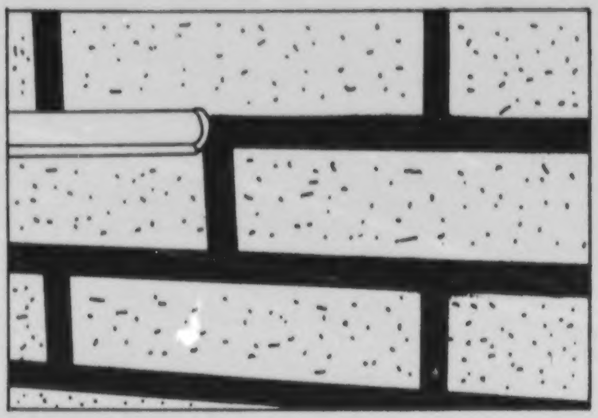


Figure 8. Jointing the Brick

Pick up the mortar from the brick with the trowel and return it to the mortar board or tub. Pick up the mortar again with the trowel, this time enough to cover two bricks, and spread evenly. The action involved in placing the mortar on the brick is a throwing or flipping action that allows the brick to be covered in one motion. This takes a considerable amount of practice. The picking up and spreading action should be repeated until it is possible for the beginner to pick up the amount of mortar needed and throw it into place in one motion. Gradually work up to spreading four bricks at a time; this is the usual amount handled at once.

When the mortar has been spread, trim excess mortar from the brick with the trowel. The trowel is still held near a horizontal position in order to keep the mortar from slipping off. The mortar may then be either replaced on the mortar board or placed on the newly spread bed joint. With the point of the trowel make a shallow furrow in the bed joint so that space will be provided when a brick is placed upon it. The complete operation of picking up, spreading, trimming, and furrowing should be practiced until the procedure can be done smoothly and quickly.

There should always be enough mortar placed on the brick to sufficiently fill the head and bed joints. This can be done easily by shoving the brick firmly against the mortar. The mortar forced out from the joints may be cut off with the trowel and used on the next joint.

Some types of brick absorb moisture easily, making it harder to press the brick into position because the mortar dries faster. The extra effort of tapping with the trowel causes a loss of time, and it has been found that wetting the brick before using it will prevent these bricks from absorbing the water from the mortar. This also results in a better bond between the brick and the mortar.

Skilled masons experiment with their movements until they find the proper rhythm for picking up the mortar, spreading it, and placing the brick in position. Generally one hand is used on the trowel, and the other is used to pick up the brick and place it in position.

Because the trowel is one of the most important tools masons use, it should be properly maintained. It should always be kept clean and free from rust. A dirty or rusted trowel slows down the work because fresh mortar has a tendency to adhere to rough places. A trowel should be stored in a special place when it is not in use.

Hammers

Several types of hammers are used in the masonry trades, and each has been designed for specific jobs or for specific materials.

Brick hammers. The brick hammer (fig. 3) is used primarily to cut hard materials, although it can be used for driving nails. It consists of a square end used for making rough breaks, driving nails, and striking chisels or brick sets. The opposite end is used for dressing up and squaring off the end of the rough break. The handle is made of hardwood or steel cushioned with nylon plastic. The head is usually constructed of high-grade forged hammer steel and weighs from 12 to 24 ounces. The weight of the head usually depends upon the strength of the masonry worker. Most masons prefer the hardwood handle.

Tile hammers. The tile hammer is shaped much like the brick hammer, but it is smaller and weighs less. It is used for cutting glazed tile and enameled brick, and can be used in emergencies for facing brick. But it should never be used for striking brick sets or driving nails because it is too light for these heavy-duty jobs.

Stone and concrete hammers. The stone hammer (fig. 4) is made of forged and tempered tool steel, is usually purchased with a 16-inch handle, and weighs about 4 pounds. This heavy hammer is ideal for working with large and bulky stones. The concrete hammer, sometimes called a bush hammer, is constructed with milled teeth on the head of the hammer (fig. 5). Some of these hammers are tapered for cutting. This hammer usually weighs between 2 and 4 pounds, and the milled head varies from 1 1/4 inches to 2 inches square. It usually has a hardwood handle.

Chisels and Jointing Tools

Although many brick cuts are made with a brick hammer—clean, sharp cuts are important for facing brick—the blocking or bolster chisel (fig. 6) is the instrument most commonly used. It has a broad edge and is made in a number of shapes and sizes. The most common has a beveled edge at the bottom of the wide blade. The chisel should be held so that the beveled edge faces the mason and the portion of the brick to be cut is away from the mason. The force of the blow varies with the type of cut and hardness of the material being used. The first sharp blow usually cracks the surface of the brick, and small taps square or smooth the rest of the cut. Cored bricks are harder to cut because they have a tendency to be weak at the cores and may fracture at the wrong place. Always keep the cutting edge straight and sharp. The striking surface of the chisel should be free of burrs that might fly off and cause injury.

Jointing tools are available in several different shapes. One of the most popular types is the convex jointer (fig. 7). After the mortar has begun to harden, the jointer is pulled along the joint (fig. 8), and a smooth contour is formed. Other commonly used jointers are the V jointer, the concave stone beader, and the raker jointer, which is used to rake excess mortar from the joint. As with other tools, using the jointer requires practice to make smooth joints consistently throughout the construction project.

Exercise

1. What is the most important tool used by the mason?
2. Name the two most commonly used trowels.
3. When using the trowel, what increases speed and efficiency?
4. From what is mortar transferred during the bricking operation?
5. How many bricks are usually spread with mortar during one operation?
6. What is done with the mortar that is forced out from between the joints of the brick?
7. What is the purpose of wetting bricks before they are laid?
8. What is the brick hammer used for?
9. How does the tile hammer differ from the brick hammer?
10. What is the most commonly used masonry chisel?
11. Name four types of jointers used in bricklaying.

E-2

Measuring and Leveling Tools

Objectives: *After completing this assignment, you will be able to—*

1. *discuss measuring, leveling, and squaring tools used in masonry work;*
2. *identify and give the uses for story poles and masonry guides; and*
3. *discuss the use of a mason's line during masonry construction.*

Rules and Tapes

The spacing rule (fig. 1) consists of a series of marks representing course heights for different thicknesses of brick or mortar joints. It is used in laying out the corner or story pole and also for laying out arches over openings.

Spacing tapes are usually 10 feet in length and contain modular markings for all common brick. Feet, inches, and fractional parts of an inch are commonly found on one edge of the blade.

Squares

Masonry workers do not usually have great need for a framing square, but they can use a small steel square, try square, or combination set. These are easy to carry and store and are necessary in keeping jambs and corners square. They are also convenient for marking bricks for cutting and other small squaring needs.

Plumb Rule

The plumb rule (fig. 2), one of the mason's most important tools, is made of either hardwood or metal and is very delicate. It is lightweight and must be completely straight. The spirit-level vials that are inserted into the rule measure both vertical and horizontal levelness. Plumb rules may be purchased in long or short sizes. Long levels measure from 42 to 48 inches, and short levels are available in lengths of 12 or 24 inches. The short levels are useful in setting soldier courses and rowlock sills, and for starting corners.

Although plumb rules are tested at the factory before shipping, they may become inaccurate through mishandling. They should be checked as soon as they are purchased as well as periodically during use. The easiest way to determine its accuracy is to check an object for levelness, determine where the bubble in the vial is located, and then reverse the plumb rule. If the bubble is between the two center marks in one direction, it should be in the same place when the plumb rule is reversed.

Mason's Line

A masons's line should be used on walls that are 4 feet long or longer. This line helps keep the brick or stone in the wall straight, level, and plumb. Masonry guides or story poles are placed at the corners of the structure being built, and the mason's line is attached to them so that it may be tightened.

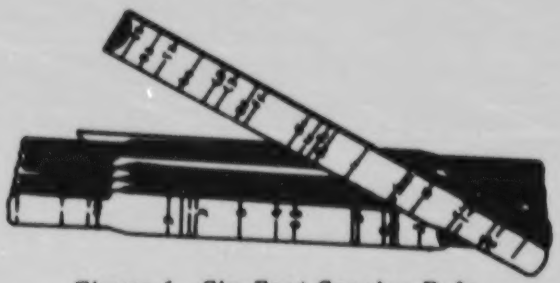


Figure 1. Six-Foot Spacing Rule

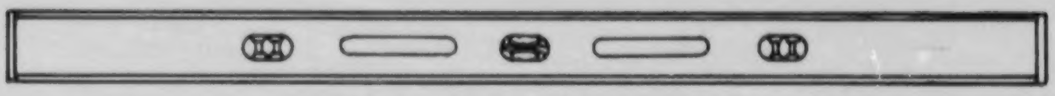


Figure 2. Plumb Rule (Level)

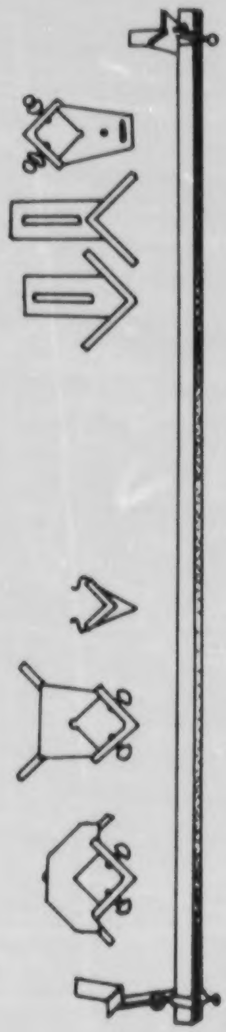


Figure 3. Masonry Guide

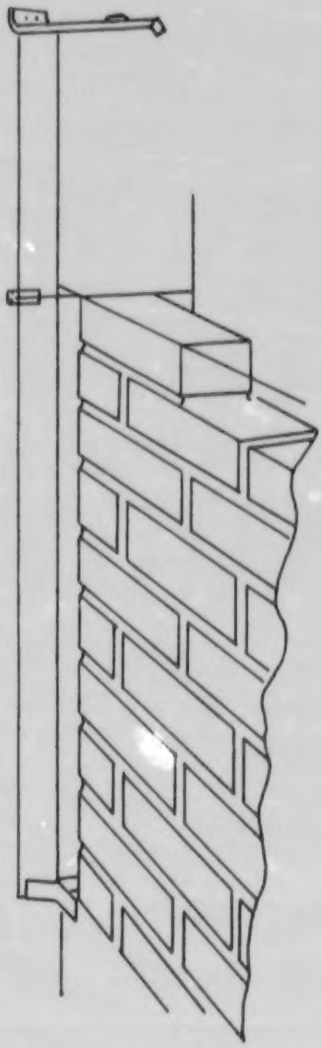


Figure 4. Story Pole

The brick is then placed with the top even with the stretched line. The mason raises the line as each course (row of brick or stone) is finished.

A mason's line is usually made of strong nylon to withstand the stress when it is tightened. When fastening the line, one mason on the left-hand lead (peg end) attaches the line of the proper course to the lead. Then the mason on the right-hand lead (pin end) pulls the line tightly and fastens it to the lead at that end. The line should be pulled until all sag has been eliminated. Any sag will cause the bricklayer or stonemason to lay an uneven course. If there is sag on a long wall and it cannot be eliminated, a trig will be needed. A trig is a short piece of line that is looped around the main mason line and fastened to the top edge of the trig brick or stone. On extremely long walls, several trigs may be needed.

After the mason's line has been stretched into place, it should be touched as little as possible. The mortar should be spread so that the trowel or mortar does not touch it. The beginning mason may have some trouble in keeping his thumb free of the line, and an experienced mason has little patience with the mason who constantly has his "thumb on the line." After the brick or stone has been set, it should never touch the line. If it did, it would be "crowding" the line and would result in the wall bulging at various points.

Masonry Guide

A masonry guide is used to lay all brick or stone in a wall without having to set up leads. This useful tool is usually made of metal and contains line blocks, or line carriers, that are attached to the poles and can be moved up or down the pole, course by course. The masonry guide replaces the story pole in almost all jobs since the coursing scale is placed upon the guide pole itself and the line blocks, or carriers, are set to each coursing mark. The masonry guide has fittings that allow the pole or support to be braced in a plumb position while still being free of the masonry wall being built. For veneer work, the top of the guide can be attached to the frame wall by means of a special fitting and plumbed independent of the frame.

After the masonry guides are set and plumbed and the mason's lines are stretched from one guide to the other, the mason can start laying brick or stone to the line without stopping to build leads. A masonry guide is shown in figure 3.

Story Pole

The story pole (fig. 4) has been almost replaced by the masonry guide, but is still available and used by some masons. It is a stick or pole usually about 10 feet long, or 1 story high and 1 inch thick by 2 inches wide. The pole should be marked on three sides with joint heights or brick gages and on the fourth side with sills, lintels, and frame heights, all marked at different levels. The pole must be laid out so that the thicknesses of the joints will match the heights of the sills, lintels, frames, and walls.

The story pole is normally set on a nail on the outside of the job, or on the first floor level on the inside. Wherever it is set, the story pole is usually on the same level as the outside. Since the heights of the windows and doors do not always match the joint heights, the difference is made up by the thicknesses of the bed joints in the brickwork.

Exercise

1. What does a mason use a 6-foot spacing rule for?
2. Why does the mason need a small steel square?
3. What types of leveling measurements may be made with the plumb rule?
4. What are short levels used for?
5. What is a mason's line attached to?
6. When is a mason's line moved to a different position?
7. What is used when there is a sag in the mason's line?
8. What device has the masonry guide replaced?
9. How long is the average story pole?

E-3

Mixing and Smoothing Tools

***Objectives:** After completing this assignment, you will be able to—*

1. *describe and give the uses for mortarboards, hods, and hoes;*
2. *discuss the uses for floats and screeds; and*
3. *identify and give the uses for edgers, groovers, and brushes.*

Mortarboards

A mortarboard is a surface constructed by wood, fiberglass, or polyethylene that is 3 to 4 feet square (fig. 1). Masonry workers use this device to hold the mortar that they will pick up with their trowel and use directly on a wall or other masonry construction. The mortarboard should be kept clean on the outer edges and the mortar should stay pushed to the center. If the mortar is spread all over the board and chopped into with the trowel, it dries quickly and hardens. When this happens, it is difficult for the bricklayer to pick up a clean trowelful, and the mortar is difficult to spread.

Mortar Hods

A mortar hod (fig. 2) is a V-shaped box with one open end used to carry mortar. It is made of steel and aluminum, and its dimensions are about 24 inches by 12 inches by 12 inches. After filling the mortar hod at the mortar source, the hod carrier holds it upright by a support known as a mortar hod shank. The hod is then raised to the shoulder and carried up a ladder or runway to the mortarboard, where it is emptied from the open end.

A mortar hoe (fig. 3) is necessary for mixing and tempering mortar. It usually has two holes through the blade, and the blade of the hoe is usually about 10 inches long. The holes allow the mortar to slip through during mixing and produces a more even consistency. For small jobs, the mortar may be mixed in a mortar box or a wheelbarrow.

Floats

Floats come in different designs and materials. The small hand-type is used on small slabs that require a small amount of smoothing. One type is shown in figure 4. The edges are slightly rounded so that cement or mortar is not cut or peeled up during the smoothing operation. A bull float is about 8 inches wide and from 4 to 5 feet long. It has a long handle so the operator can stand while smoothing large areas.

Screeds

Screeds are used to level concrete after it has been poured. They are long wooden or metal devices that stretch across from the outer forms. They are pulled from one end of the slab to the other, pushing any excess concrete ahead of the screed to leave a level surface behind.

Edgers

Edgers (fig. 5) are used to make a rounded edge or radius on slabs or walks. They are

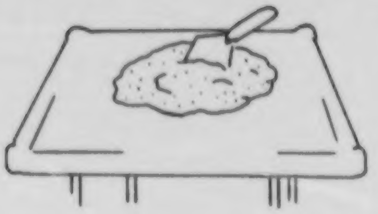


Figure 1. Fiberglass Mortarboard

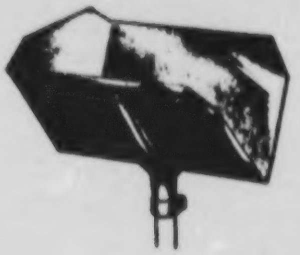


Figure 2. Mortar Hod

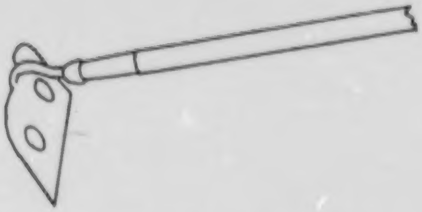


Figure 3. Mortar Hoe

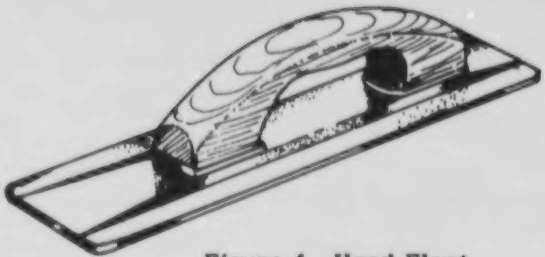


Figure 4. Hand Float

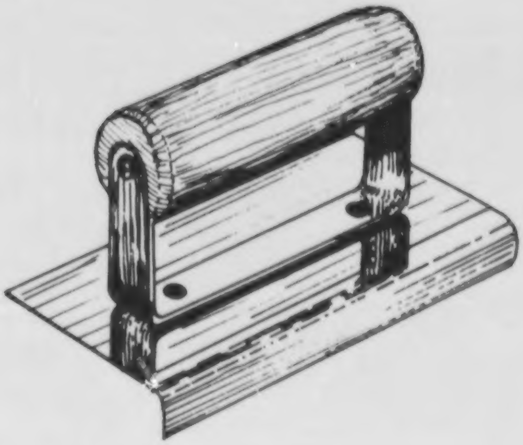


Figure 5. Hand Edger

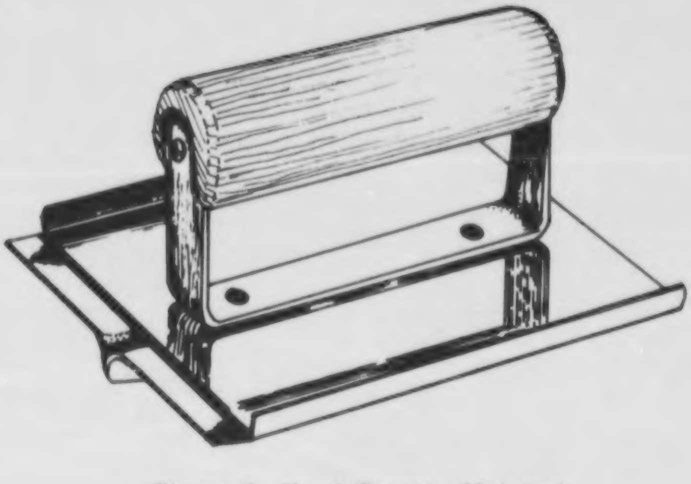


Figure 6. Hand Groover (Jointer)

usually about 6 inches long and vary in width from 1 1/2 to 4 inches. Edgers are available with long handles so the worker can work while standing.

Groovers

The groover, or jointer (fig. 6) cuts a line or groove into the cement to help prevent cracks. The bottom of the groover (the bit) cuts to depths varying from 1/2 inch to 1 1/2 inches. Groovers are about 6 inches long and range in width from 2 to 4 1/2 inches. They are available with long handles.

Brushes

Brushes or brooms are sometimes used to make the surface of concrete rough to prevent falls during wet weather. These brushes have stiff bristles to allow for better penetration into the concrete surface. Other types of brushes are used to clean joints after joining brick or stone with mortar.

Exercise

1. What is the purpose of a mortarboard?
2. What happens if the mortar is spread all over the mortarboard?
3. What is a mortar hod?
4. How does a mortar hoe differ from a regular hoe?
5. Why are the edges of floats slightly rounded?
6. How large is a bull float?
7. What is the purpose of a screed?
8. What tool is used to make a rounded edge or radius on slabs or walks?
9. What does a groover or jointer do?
10. What devices are used to make the surface of concrete rough?

E-4

Heavy Masonry Equipment

***Objectives**: After completing this assignment, you will be able to—*

1. *describe and list uses of hoisting devices;*
2. *describe and list uses of power operated screeds, trowels, cutters, saws, and tamping devices;*
3. *discuss scaffolds that are used in masonry work; and*
4. *discuss the use of portable concrete mixers and wheelbarrows.*

Hoisting Devices

Gin poles, breast derricks, and **pole derricks** are hoisting devices commonly used for lifting stones on buildings that are not more than two or three stories high. Larger buildings of fireproof construction (in which the floors are held by a skeleton steel frame built in advance of the erection of the enclosing walls) require a small derrick or derrick boom attached to the frame of the building.

The gin pole is a pole held in position by guy wires with a block and tackle at the top for hoisting the stone. The block and tackle may be operated either by hand or by a winch. The breast derrick (fig. 1) has two upright supports latticed together in the form of a ladder, with a winch at the bottom. The derrick leans against the wall or is supported by guy wires. It is usually operated by hand. The pole derrick (fig. 2) combines the features of the gin pole and the breast derrick. It is a square pole, mounted and braced on a base member that rests on small wheels and is fitted with a winch, pulleys, and tackles.

There are several ways of picking up stone and attaching it to the block and tackle of a derrick so that it may be hoisted into position. The stone may be lifted with "dogs" (fig. 3) that are attached to the derrick sling. This method can be used only where vertical joints occur in both ends of the stone. Lewises may also be used (fig. 4). The type of lewis most commonly used for lifting a stone occurring in the horizontal course of the cornice is the pin lewis. It has two pins that are from 5/8 to 1 inch in diameter and rings that are attached in the ends and carried by means of a sling. These pins are inserted in holes drilled diagonally toward the center near each end and on the top bed of stones. A similar pin lewis has two pins that are carried by a ring instead of a sling. It is used for lifting smaller, square-shaped blocks.

A steel grabhook, which looks much like a large pair of ice tongs, is commonly used to hold small stones during placement. A block of wood, which may be surfaced with lead, is placed between the spring of the grabhook and face of the stone. This protects the face of the stone. On the back of the stone a small depression is chiseled to receive the other prong of the grabhook.

Brick tongs (fig. 5) are used to carry small quantities, usually from 6 to 10 bricks. Brick tongs are made of flat malleable iron or tubular steel. Adjustments to carry a certain number of units can be made in seconds.

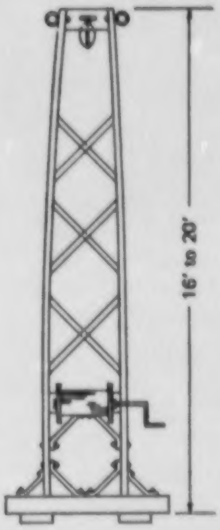


Figure 1. Breast Derrick

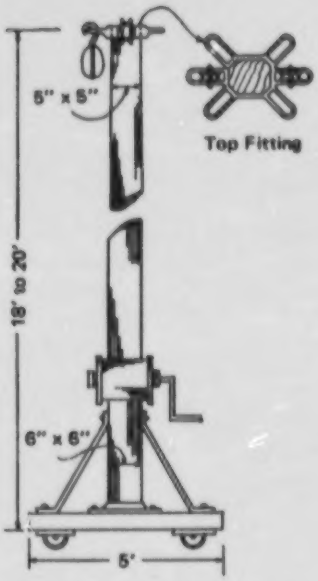

5" x 5"
Top Fitting
18' to 20'
6" x 6"
5'

Figure 2. Pole Derrick

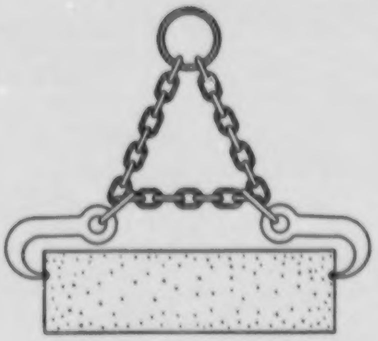
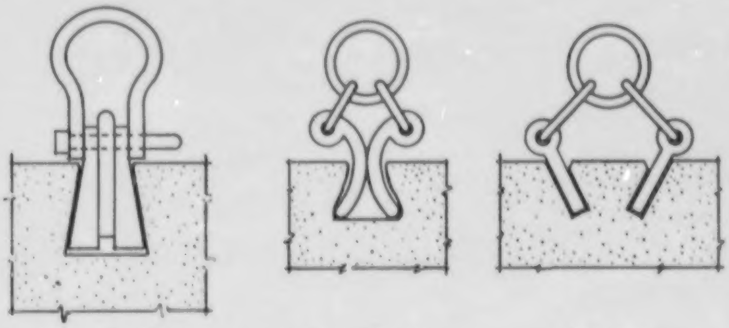


Figure 3. Masonry Dogs



Three-leg Lewis Knuckle Lewis Pin Lewis

Figure 4. Masonry Lewises

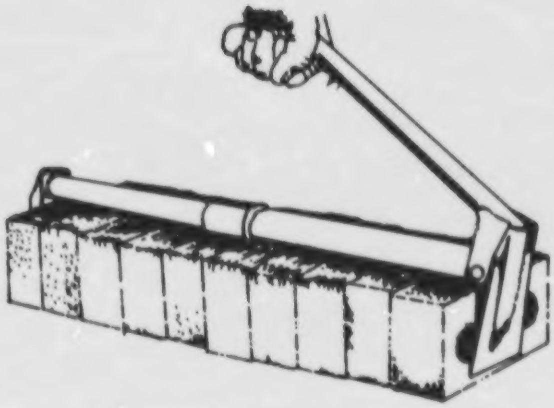


Figure 5. Brick Tongs

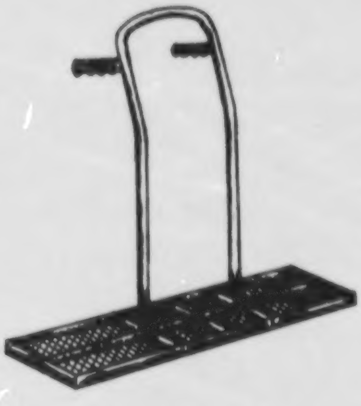


Figure 6. Jitterbug Tamper

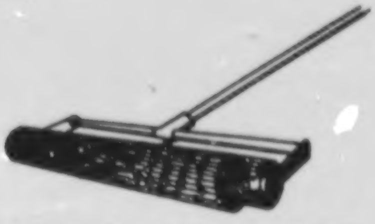


Figure 7. Rollerbug Tamper

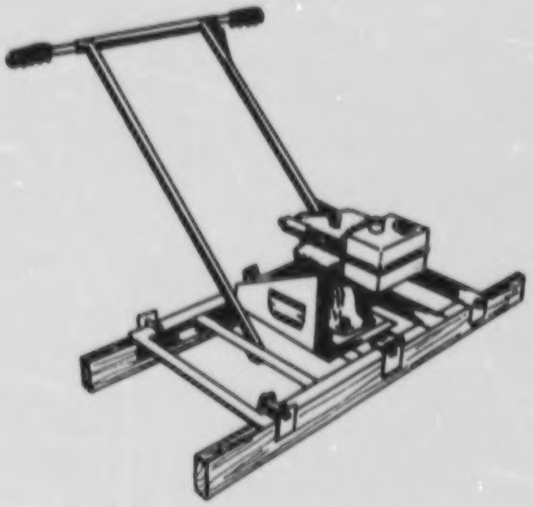


Figure 8. Power Screed

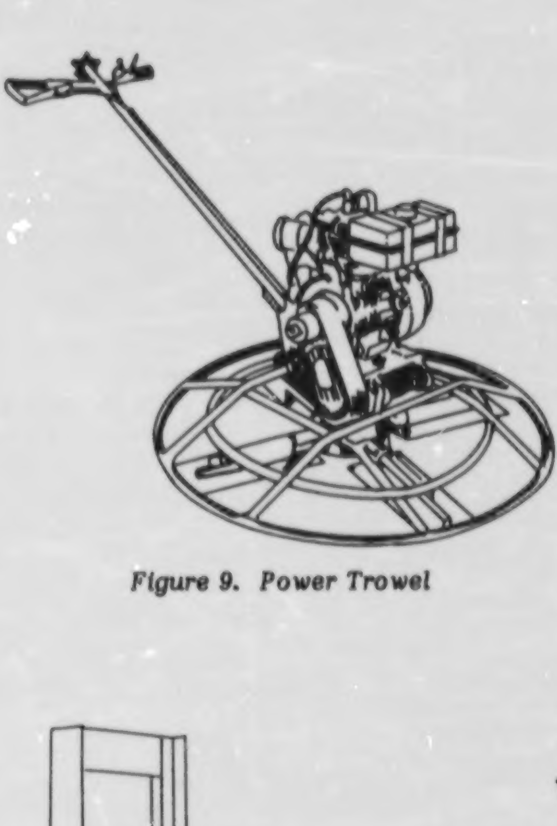


Figure 9. Power Trowel

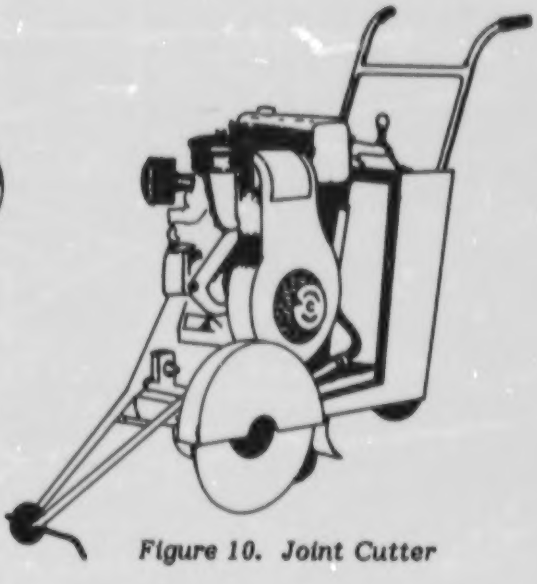


Figure 10. Joint Cutter

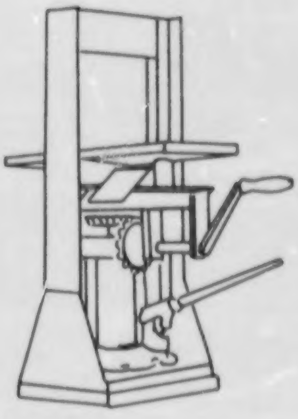


Figure 11. Hydraulic Cutter

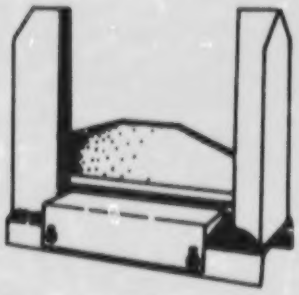


Figure 12. Hand Splitter

Tamping Devices

Although there are a number of tampers, the Jitterbug (fig. 6) and the Rollerbug (fig. 7) are commonly used to bring fine material to the top of the slab to give a smooth surface.

Power Screeds

The screed shown in figure 8 is powered by a 3 hp gasoline engine. This device strikes off, compacts and floats the slab in one pass. Screeds can be fitted with boards to make runs up to 16 feet in width.

Power Trowels

A gasoline-powered trowel (fig. 9) is used to give a professional, smooth finish to large slabs. Trowels vary in size from about 28 to 46 inches.

Power Joint Cutters

A joint cutter (fig. 10) is used to saw construction joints, repair damaged areas, and to cut openings in masonry materials. Joint cutters are equipped with powerful gasoline engines and the cuts are cooled with water as the cutter is moved along. Most make cuts up to 5 inches deep and can be used within 2 inches of walls.

Masonry Cutters

There are several types of masonry cutters or splitters, but the most common are the hydraulic cutter and the hand splitter. The hydraulic cutter (fig. 11) is operated by a hydraulic pump. The blade is placed against the stone, the handle is pumped, and the pressure splits the stone. The units are usually constructed of high-grade steel with hard edge blades. The hand splitter (fig. 12) is used in conjunction with a heavy hammer or sledge. The stone is positioned beneath the blade at the indicated cut, then a 2- to 4-pound hammer gives the upper edge of the blade a solid blow. The stone then parts at the point of impact. This type of splitter is used by the mason who does not do a great deal of stonework.

Masonry Saws

The masonry saw (fig. 13) comes in a variety of sizes, but the 14- to 20-inch blades are the most common. Some masonry saws cut wet, and others are used without lubrication. Those with water pumps are more expensive. Masonry saws can be adjusted to cut different sizes.

Portable Concrete Mixers

The mason who does small jobs has a great need for a concrete mixer because these jobs generally will not require the services of a truck mixer. Many masons use a portable mixer because it is easy to place at the building site. The wheelbarrow type (fig. 14) is very convenient, and it may also be used as a wheelbarrow. While most mixers have revolving drums containing fixed blades inside, some types have fixed drums with revolving blades or paddles. They are usually powered by an electric motor fastened to the upper frame. Mixers should be cleaned immediately after each use.

Scaffolds

Although scaffold safety was covered at the first of this manual, you should know what types of scaffolds are used.

The **swing-stage scaffold** has been used for many years in the construction of tall, skeleton-frame buildings, but the advantages of these continuously adjustable scaffolds were not fully realized until recently. When using these scaffolds, the bricklayer can keep materials handy and work at convenient heights. This eliminates much of the unnecessary fatigue encountered otherwise.

The **tower scaffold** has vertical towers that are braced to the building constructed. A carriage provides the mason's materials, and there are platforms that can be raised by a hand winch suspended by a cable from the top of the tower.

The **tubular scaffold** with adjustable brackets (fig. 15) places the platform at various heights so the mason and the materials are always at a workable height. Many types may be adjusted for high, long, or wide jobs.

Wheelbarrows

Although wheelbarrows may be constructed of either steel or wood, most that are used for transporting mortar are made of metal because of the excessive weight. Brick and tile wheelbarrows (fig. 16) are usually made

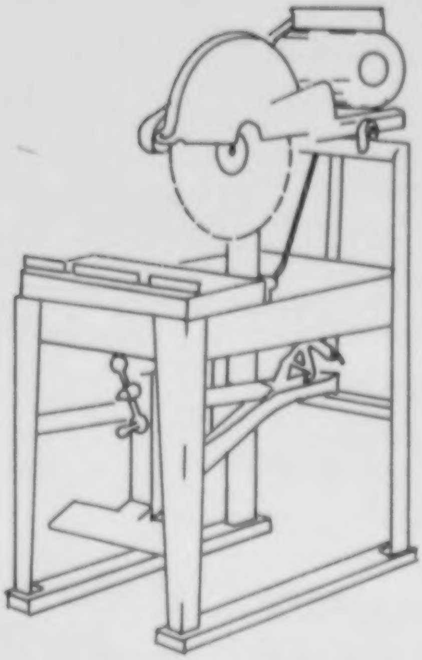


Figure 13. Masonry Saw

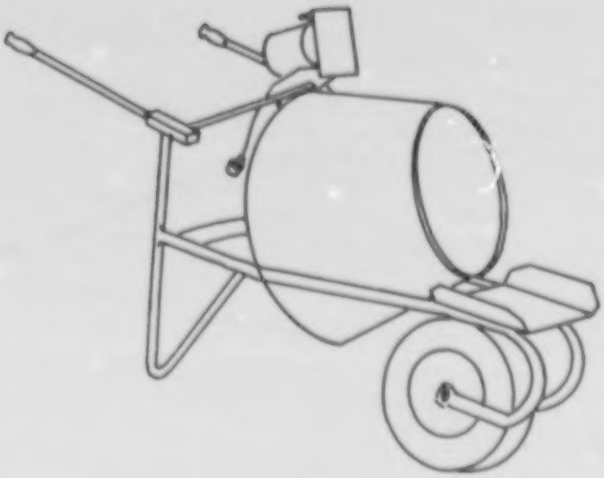


Figure 14. Wheelbarrow Concrete Mixer

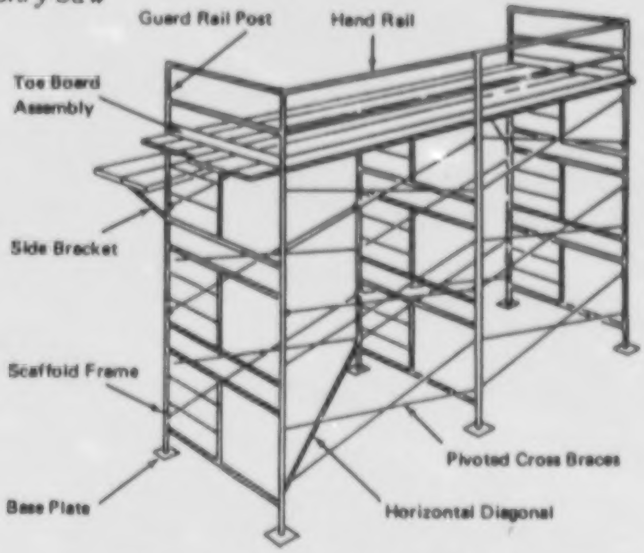

Guard Rail Post
Hand Rail
Toe Board Assembly
Side Bracket
Scaffold Frame
Base Plate
Pivoted Cross Braces
Horizontal Diagonal

Figure 15. Tubular Scaffold

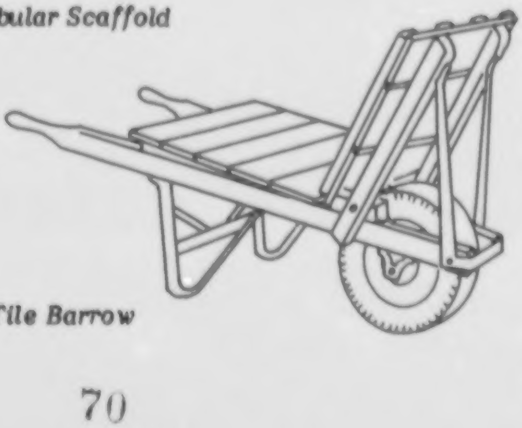


Figure 16. Brick and Tile Barrow

of wood and can carry up to 120 bricks. Wheelbarrows are used when it is impossible to use other vehicles to transport mortar, brick, or tile to the construction site.

Exercise

1. Name three types of hoisting devices used for lifting stones.
2. What type of lewis is used for lifting stones occurring in the horizontal course of the cornice?
3. What device is used for holding small stones during placement?
4. Name two types of masonry cutters.
5. What other tool must be used with the hand splitter when cutting stone?
6. What sizes of saw blades are commonly used in the masonry saw?
7. What should be done immediately after a concrete mixer is used?
8. What is used to carry small quantities of brick?
9. What two tools are commonly used to bring fine materials to the top of the slab for a smooth surface?
10. What are power screeds used for?
11. How large are power trowels?
12. What are joint cutters used for?
13. What type of scaffold has been used for many years in the construction of tall, skeleton-frame buildings?
14. How many bricks can a brick and tile wheelbarrow carry?

F-1

Cement, Lime, Mortar, and Concrete

Objectives: *After completing this assignment, you will be able to—*

1. *discuss the mixtures of and uses for cement;*
2. *give the mixing procedures and uses for mortar; and*
3. *discuss the mixtures of and methods for using concrete.*

Cement

Cement was first made by burning and slaking a certain limestone so that the mixture would harden into a solid mass under water as well as in the open air. The first portland cement was produced by calcining a mixture of limestone and clay. Today this cement consists of finely ground compounds of lime with silica, alumina, and iron oxide added. Two methods of manufacturing this cement are the dry process and the wet process. In the dry process, the raw material is ground up, mixed, and fed into a kiln (oven). In the wet process, the raw material is ground, mixed, and fed into a kiln containing water.

Lime

Lime, which is often used with cement or mortar in residential and commercial construction, is a product of limestone when it is heated to 1,700°F. This process also releases carbon dioxide. The material left after heating is known as **quicklime**. Today, we use a chemically treated quicklime called **hydrated lime**.

Mortar

Mortar may be a mixture of lime, sand, and water; lime, sand, cement, and water; or cement, sand, and water. The cement is usually portland cement.

Types of mortar. The two basic types of mortar are that for unit masonry (C 270) and that for reinforced masonry (C 476). The mortar specific as C 270 is broken into five different types, which are designated by the letters M, S, N, O, and K. These letters indicate the different percentages of portland cement in the mix. There are many grades of mortar in the C 270 specification because each of the mortars has different properties, but none has all of the properties needed for every job. Some have good workability, but low strength; others have high strength, but relatively poor workability. Table 1 gives the proportions found in each type of C 270.

Masonry cements are normally mixtures of portland cement and other materials that are used to produce plasticity or workability. Lime or ground limestone may be the added ingredient. Masonry cements may be used in combination with portland cement as in type M and S mortars. Masonry cements should never be used in place of portland cement.

Admixtures. Mortar admixtures are materials that may be added to mortar mixes. Usually used in small amounts, admixtures produce a particular desired result, such as increased workability, increased bonding of the mortar to the masonry units, or added color to the mixture. Although the admixtures may improve one or more properties of the mortar, they may also reduce other properties. Admixtures should not be used unless they are needed, and they must meet specifications.

Table 1
Proportions for Lettered Types of C270 Mortar

Portland Cement-Lime Mortars

Type	*Portland Cement*	*Hydrated Lime or Lime Putty*	*Sand*
M	1	¼	3
S	1	½	4½
N	1	1	6
O	1	2	9
K	1	3	12

Masonry Cement Mortars

Type	*Portland Cement*	*Masonry Cement Type II*	*Sand*
M	1	1	6
S	½	1	4½
N	—	1	3
O	—	1	3

Mixing. When mixing mortar, begin with dry materials. Then add water until the mixture is smooth and workable. Mechanical mixers usually accomplish this better, but on small jobs you may mix mortar by hand in a mortar box. You should mix no more mortar than can be spread in 2 1/2 hours. If water evaporation causes the mortar to harden, retemper it with more water and remix.

Concrete

Aggregates. Aggregates used in concrete are usually made of sand, gravel, crushed stone, or a combination of any of these. Aggregates usually make up from 60 to 80 percent of the concrete mixture and are used primarily as filler. You will want to select the aggregates to suit each job. Some aggregates are harder or have more resistance to weather than others. Others react chemically to the cement, causing cracking or abnormal expansion of the material. It requires more cement to produce good quality concrete when flat, elongated, or rough-textured particles are used. There is very little difference in strength between concrete containing rough-textured particles and that containing rounded particles.

The aggregates most suitable for concrete are hard and durable. Soft, flaky aggregates wear away rapidly and cause a loss of strength in the concrete. Aggregates should also be free of foreign particles, such as fine dust, silt, or organic matter, because a dirty aggregate will not cement correctly and will weaken the mixture. Fine or coarse aggregates are used according to the specifications of the job.

Qualities. For concrete to be usable, it must be economical, workable during the application stage, and have the desired qualities when hard. A good concrete must be watertight, resistant to freezing and thawing, strong, and capable of wear resistance. These qualities depend on entrained air, the water-cement ratio, and curing. Entrained air is air that has been trapped in the mixture, usually during mixing. It is used in concrete that is subject to freezing and thawing because it allows the mixture to move. It also improves the workability of the material at the time of application. The size of the aggregate determines the amount of air required for freezing and thawing protection.

Curing. Concrete hardens through hydration, which is the chemical reaction that takes place between the portland cement and water. The properties of concrete such as durability, strength, and wear resistance, improve with age as long as there are favorable temperatures and moisture. It usually takes about 3 gallons of water to hydrate each bag of cement. However, more water may be necessary because of evaporation. If the loss of water is too rapid, the concrete may shrink. Therefore, steps should be taken to keep the material moist for about seven days after application. You may cure the concrete by flooding or mist spraying, adding a damp cover, sealing the material with waterproof paper or plastic, or spraying on chemical solutions to hold in the moisture.

Exercise

1. What are the two methods of manufacturing portland cement?
2. What is lime called after the carbon dioxide has been released from the material?
3. What is hydrated lime?
4. What type of cement is normally used in mortar?
5. What are mortar admixtures?
6. When mixing mortar, what state should the materials be in?
7. What aggregates are usually used to make concrete?
8. What process causes concrete to harden?
9. How is concrete cured?
10. What is entrained air?
11. What determines the amount of air required for freezing and thawing protection?

F-2

Brick, Tile, Block, and Stone

Objectives: *After completing this assignment, you will be able to—*

1. *discuss the sizes, types, and characteristics of brick and tile;*
2. *discuss the manufacture and identification of cement and glass blocks; and*
3. *give the origin and uses of various types of stone.*

Brick

A brick is a building unit made of baked clay. The temperature used in the kiln in which the brick is baked is at least 2,000°F. Bricks vary in size, but one with a length of 8 inches, a width of 3 3/4 inches, and a depth of 2 1/4 inches is considered standard. The width of two bricks, plus a mortar joint, should equal the length of one brick.

Types of brick. The American Society for Testing and Materials has classified the most commonly used bricks into three categories. A C-62 brick is a **building brick**; a C-216 brick is a **facing brick**; and a C-126 identifies a **ceramic-glazed structural clay facing tile, facing brick**, or **solid masonry unit**. The building brick category consists of three grades based on resistance to weathering; SW (severe weathering), MW (medium weathering), and NW (no weathering). The facing brick category includes the grades SW and MW plus three types of brick that are rated according to appearance.

Building (common) bricks are made out of ordinary clay and baked in the usual manner in a kiln. They are used in ordinary walls and buildings where there is not a specific need for special effects in appearance. You would use facing bricks for the outside of the wall and where accurate bonding or fitting is needed because facing bricks are more uniform in size than common bricks. Facing bricks are available in a wide variety of colors and textures. Glazed bricks are usually uniform in size because they are made in a mold and then treated to give a glazed surface. They come in a variety of colors, but probably the most popular is white. Glazed bricks are used where sanitation and cleanliness are of first importance.

Firebricks are made from fireclay, a material that withstands a great amount of heat and does not crack or break into pieces when exposed to fire. These bricks are used to line fireplaces, blast furnaces, and some types of boilers. They are usually slightly larger then common bricks and much heavier.

Characteristics. Good building bricks should be sound and free from cracks, flaws, and lumps of lime. Lime found in lumps may cause the brick to split. For good brickwork, bricks must be regular in shape and uniform in size, and the edges should be square, straight, and sharply defined. The surfaces should be even and not so smooth that mortar cannot stick to them. Good bricks should not absorb much water. They should be hard and baked so that there is thorough **vitrification** throughout the brick. Vitrified material is heated until it has low porosity (is glassy). When good bricks are struck together, they should make a ringing sound. A dull sound indicates the brick is too soft.

Tile

Hollow tile is a brick material used commercially where bricks were previously used—in partitions and for furring. Tile, made in various sizes usually larger than bricks, offers more bulk without a corresponding increase in weight. It is more dampproof when used on the interior of walls and is also less likely to convey sound and vibration. With hollow tile you can lay up more wall in a given time using less mortar. Hollow tile can also be plastered readily. If used in the proper location in conformity with correct stress calculations, it does not interfere with the stability of the wall. Hollow tile usually requires facing brick on the outside and is tied into the tiling by headers. Hollow tile is generally more economical to lay than bricks. The process involves the same principles as laying bricks, but is considered rough work. Hollow tile is easier to lay and does not require as much accuracy.

Terra-Cotta

Terra-cotta is another substitute for brick, although in the trade it is understood to be a brick material made up into parts for a wall according to a particular purpose or design. It requires a better quality of clay then bricks do. Ornamentation for building fronts, windowsills, arches, cornices, parapet walls, panels, and moldings may be terra-cotta made for that particular purpose. The term **terra-cotta** means "earth cooked" or a kind of pottery. As a brick material, it ranges in color from white to a deep red, but the most common shade in the United States is a light, cream-colored yellow with a glazed surface.

Concrete Masonry

Concrete masonry is an assembly of precast concrete blocks used in building construction. Although these blocks are made in a variety of shapes and sizes, the 8-inch by 8-inch by 16-inch size is probably the most widely used. When used in single-block thickness, it produces an 8-inch thick wall with courses (layers) 8 inches high. One of these blocks takes up the same space as twelve bricks, with the height of the block equaling the height of three courses of brick. Blocks are also available in 4-, 10-, and 12-inch widths. Half-length blocks are usually available. This makes it unnecessary to cut full-length units on the job.

Concrete blocks are constructed with cores, or air spaces that take up about 50 percent of the total volume. These cores conduct heat more readily and save materials. The cores also mean that the blocks weigh less and are more easily handled. Most block manufacturers construct corner blocks, sills, lintels (load-bearing supports above building openings), door and window jamb blocks, and other concrete specials. Concrete bricks are also usually available where brick-sized units are needed.

Portland cement and either fine or coarse aggregates are used in the manufacture of concrete masonry blocks. Heavy blocks are made with aggregates of sand and gravel or crushed stone; light blocks are made with expanded clays or shales, expanded slags, cinders, or pumice, which is a volcanic glass. The blocks are made by tamping, vibrating, or pressure, then cured in a kiln, after which they are stored and dried for several weeks before being used.

Most concrete masonry blocks are made with flat or straight faces. The face textures are changed through various proportions of fine and coarse aggregates. Other face treatments include brushing with a wire or bristle brush soon after the molding operation, or using a special facing mix that contains either mineral oxide pigments or colored aggregates, or both. Portland cement paint may also be purchased for application to the surface of the material.

Cast Stone

Cast stone is building made from concrete. By constructing the molds in different shapes and using selected aggregate, various effects may be achieved. Molds are usually made of plaster of paris, metal, wood, or sand; however, plaster is generally used for making models and molds for ornamental cast stone. When the model is finished, it is shellacked and oiled, and a mold is made from it. After the model is removed, the concrete is poured into the mold and left to dry. These molds may be used several times. Metal and wood molds are made by a similar process. When sand is used for molding, it should be finely-ground and should mold well when wet. Sand has a tendency to stick to concrete surfaces, which means that after the stone is cast, its surface will require some treatment. Mineral pigments may be used to produce various color effects.

Types of Stone

Three types of natural stone are used in the construction or repair of a building. They are rubble, ashlar, and trimmings.

Rubble stones are used for rough work, such as building foundations. These stones usually come from near the construction area and may be granite, limestone, sandstone, field stones, or quarried stones. Quarried stones are much better than common field stones, because they will result in better bonding and bedding. Uncoursed rubble stones are irregularly shaped stones set at random, and coursed rubble stones are irregularly shaped stones set up in courses. Most of the shaping of these stones is done with a hammer. Use of common field stones may create bonds that are weak because of the cavities that are filled with either mortar or stone chips.

Ashlar masonry consists of the facing of squared stones. The outside surface of these stones is usually given a fine finish. It is not classified as ashlar unless the joints between the stones run horizontal and vertical. The two classes of ashlar masonry are coursed and broken (or ranged). Coursed ashlar consists of stones that are of uniform height and placed in continuous courses. The stones are usually 12 inches high and from 18 to 24 inches long. Broken, or ranged, ashlar consists of stones that are square or rectangular and of various sizes. They will not form an unbroken course.

Masonry trimmings are used in moldings, belt courses, or sills, and they are used mostly for ornamental purposes. Mortar for stones should be kept to a minimum. The average thickness of a joint is about 1/4 inch, but can vary from 3/16 to 5/8 inch.

Stone finishes

Several finishes may be applied to the face of the stone to add to its appearance. The rock face may be left as it was when it was removed from the quarry, usually with the edges chipped down to a line for consistency. The **crandalled** effect, which appears on softer stones, has fine parallel lines tooled across the surface of the face. A **bush-hammered** stone is dressed to a fairly even surface and finished with parallel lines made with a hammer. A **vermiculated** finish is made up of short, twisting grooves that have been gouged into the surface of the stone. (Because of the extra effort involved in creating this finish, it is much more expensive than other finishes.) The **rubbed** finish consists of finishing the face until it has a smooth surface. The **polished** finish is similar to the rubbed finish, but the smoothing is carried to an extreme degree. This type of finish is usually applied to marble and granite.

Kinds of Stone

Five different kinds of stone are most commonly used in the United States for construction and repair purposes. They are limestone, granite, sandstone, bluestone, and marble. They may be used alone or in combinations that add either strength or beauty to the structure.

Limestone is an aqueous (formed by the action of water) stone that consists largely of shell deposits. Most limestone is a buff or gray shade though there are other colors. This is a fairly soft stone that is usually cut from the ground in huge slabs. It is used for the construction of public buildings and for residences.

Granite is an igneous (produced by heat) rock that is very hard and can be polished, although it is normally used as a building stone. It is found in both fine and coarse textures, and colors vary from white to pink, red, and green. Because of its durability, granite may be used for doorsteps and windowsills of public buildings.

Sandstone, similar in texture to limestone, was used for many years for the fronts of commercial buildings or for expensive homes. However, this material did not resist frost, its color was dull, and it flaked rapidly. It was later found that when the stone was laid horizontally, it did not chip as often.

Bluestone is a fossilized clay that varies widely in hardness. Most bluestone is used for patio flagstones or where there is both a need for a ground covering and an attractive pattern.

Marble varies in color, hardness, and cost. The stone is sometimes used only for keystones, windowsills, or ornamentation on the outside of a structure. Interior uses include fireplace facings and floor tiles. Expensive structures or monuments may use marble throughout.

Glass Block

Glass blocks are used in some buildings. These blocks are hollow units of clear, pressed glass available in a great variety of shapes. Most blocks are constructed in two parts and then sealed together. The air space in the center of the block gives excellent insulation to the unit. The part of the block that is designed to be next to the mortar features a groove of a gritty, moisture-resistant substance. This causes the mortar to bond successfully with the unit.

Glass blocks afford better light control than any other masonry product. The **functional** glass block controls both the diffusion and distribution of light rays in the directions desired. The **general-purpose** glass block is made for direct light transmission. **Decorative** glass blocks are used for appearance, as the name implies. Sometimes all three types of blocks are used in one structure.

Exercise

1. From what material are bricks composed?
2. Name the three types of common brick.
3. When two bricks are struck against each other, what does a dull sound indicate?
4. What are the advantages of hollow tile in construction?
5. What is terra-cotta?
6. What is the most widely used size of concrete block?
7. What materials are used to make concrete blocks?
8. Name the three types of natural stone that are used in the construction industry.
9. What is the main difference in the origin of limestone and granite?
10. Other than insulating qualities, what is the feature that glass blocks offer that is better than other masonry products?

F-3

Metal Ties, Steel Bearing Plates, and Flashing

Objectives: *After completing this assignment, you will be able to—*

1. *identify and discuss the various types of ties that are used in masonry construction;*
2. *discuss the use of steel bearing plates; and*
3. *give the purposes of flashing in building construction.*

Metal Ties

Walls in which the separate tiers, or wythes, are tied together or bonded by metal ties are better for some uses than similar walls bonded with masonry units or brick headers. Sometimes metal ties are used to attach brick veneer to walls with wooden frames or to other structural walls.

Veneer ties are smaller gauged than the ties used in cavity or metal-tied walls, When these ties are used, the veneer cannot be considered to be part of the required thickness of the wall. For instance, if a building code specifies that the minimum thickness of a masonry wall is 8 inches for a certain structure and the wall is veneered with 4 inches of brick attached to the backup with veneer ties, the backup must be the required 8 inches. If the mason uses heavier ties, the backup necessary is only 4 inches because the 4 inches of brick veneer is then part of the required 8-inch thickness.

The corrugated veneer tie and the dovetail anchor are two types of ties that are normally used to attach brick veneer to backing walls (fig. 1). The corrugated metal tie is commonly used to attach brick veneer to wooden frames. These metal ties are usually constructed of galvanized steel at least 7/8-inch wide and 22-gauge thickness. There should be one of these metal ties for each 2 square feet of wall area, and the ties should not be spaced further than 24 inches apart either horizontally or vertically.

Corrugated ties should be fastened to the wall studs with eight-penny nails. Care should be taken that they are not nailed to the sheathing, especially fiberboard sheathing, because the material is not strong enough to hold the nail in place. Because most studs are spaced on 16-inch centers, the maximum vertical spacing of the ties can be figured by dividing 288 square inches by 16 inches; the answer is 18 inches. For brick application of three courses to every 8 inches, this requires one row of wall ties for every sixth course.

The dovetail anchor is used to attach brick veneer to concrete walls, columns, or beams. This tie fits into a slot formed in the concrete. The dovetail is at least 7/8-inch wide and constructed of 16-gauge material.

Metal ties for cavity and metal-tied walls are the Z tie and the rectangular tie (fig. 2). The Z tie is used when walls are constructed of brick or other solid masonry units. The rectangular tie is used in walls where one or both wythes are of hollow units. The ties are constructed of copper or zinc-coated steel with a 3/16-inch diameter. They are usually placed so that there is one tie for each 4 1/2 square feet of wall surface. Sometimes there is a combination of metal ties and joint reinforcement.

Steel Bearing Plates

Steel bearing plates (fig. 3) are placed on walls or piers to support steel beams or

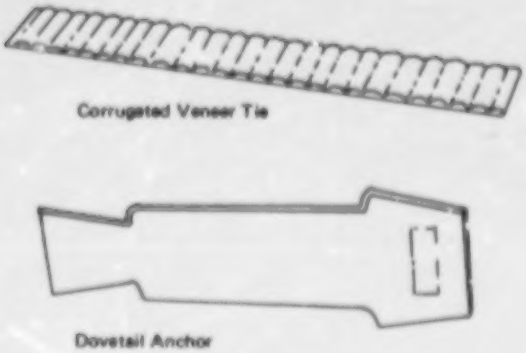

Corrugated Veneer Tie
Dovetail Anchor

Figure 1. Brick Veneer Ties

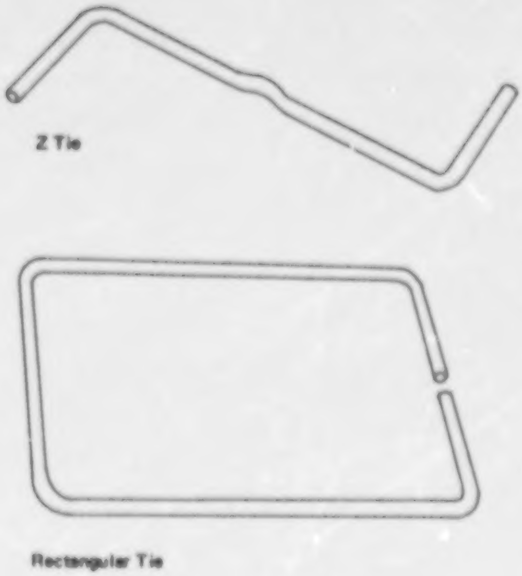

Z Tie
Rectangular Tie

Figure 2. Wall Ties

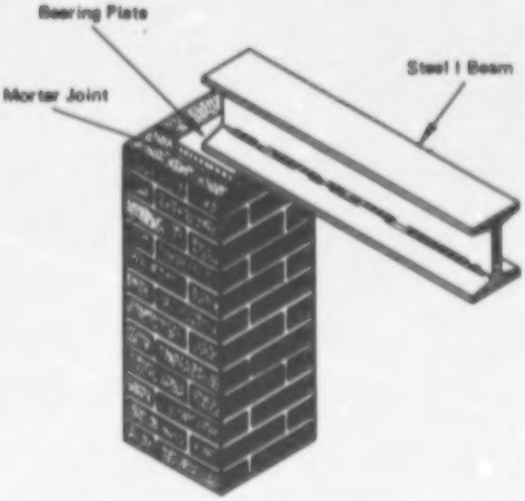

Bearing Plate
Mortar Joint
Steel I Beam

Figure 3. Steel Bearing Plate

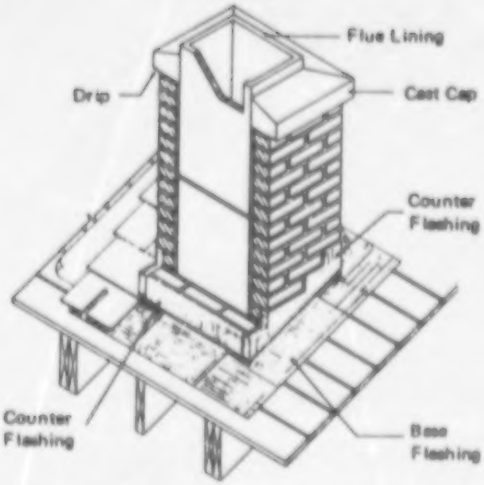

Flue Lining
Drip
Cast Cap
Counter Flashing
Counter Flashing
Base Flashing

Figure 4. Chimney Flashing

girders. They distribute the weight over a larger area. This helps prevent cracking or breaking at a critical location. They are usually fairly thick so that bending is prevented when a heavy load is placed upon them. The specifications usually give the thicknesses recommended. The plates should be bedded in mortar, and placed in a level position. The bedding of mortar should be thicker than necessary for the finished job. This will allow the bearing plate to be tapped down to the exact mark and will assure that the bed is solid.

Flashing

There are a number of places in building construction where moisture may enter masonry. Flashing is made of flat sheet metal and installed to divert this moisture to the outside of the structure. It should be placed under horizontal masonry surfaces such as copings and sills, at intersections of masonry walls with horizontal surfaces, over heads of openings, and sometimes at roof lines. Flashing installed at a chimney is shown in figure 4.

The flashing should extend through the outer face of the wall and be turned down to remove the moisture to the outside. Weep holes should be provided every 1 1/2 to 2 feet to allow the water to drain to the outside. It is sometimes necessary to stop the flashing before it extends through the face of the wall to keep from marring the appearance of the construction. Weep holes must be provided in this instance, or the moisture will be left inside the structure.

Exercise

1. How do veneer ties differ from those used in cavity or metal-tied walls?
2. Where is the corrugated metal tie used?
3. How should corrugated ties be fastened to wall studs?
4. Where is the dovetail anchor used?
5. From what material is the Z tie constructed?
6. What is the purpose of steel bearing plates?
7. Why is flashing used in masonry work?
8. What are weep holes?
9. Why should corrugated ties not be fastened to sheathing?
10. How are steel bearing plates bedded?

G-1

Brick Bonds

Objectives: *After completing this assignment, you will be able to—*

1. *explain the various positions in which bricks may be laid;*
2. *discuss bond terms and how to select the correct type of bond; and*
3. *define the various types of structural, pattern, and mortar bonds.*

Selection of Bonds

Brick positions. The position in which a brick is placed in a structure has a great deal of effect upon both the strength and appearance of the finished product (fig. 1). Bricks that are placed lengthwise on the wall with the longest edges parallel to the face of the wall are called **stretchers.** **Headers** are bricks that are placed at right angles to the stretchers or across the wall with the ends parallel to the face of the wall. **Soldier bricks** are placed in a vertical position with the edges facing the front of the wall. **Sailor bricks** are placed in a vertical position with the faces of the bricks facing the front of the wall. A **shiner brick** is placed lengthwise on the wall with the face or width of the brick toward the front of the wall. A **rowlock** position is achieved when the brick is set on edge with the end toward the front of the wall.

Bond and joint terms. It is important to know the terms associated with the brick when it is placed into position. The **course** is one of the continuous horizontal layers of units (bricks) that is bonded with mortar (fig. 2). A **wythe** consists of each continuous vertical section of masonry that is one unit in thickness (fig. 3).

There are also three joint terms you should know (fig. 4). The **bed joint** is the horizontal layer of mortar on which a masonry unit is laid. The **collar joint** is the vertical, longitudinal joint between wythes of masonry. The **head joint** is the vertical mortar joint between ends of masonry units. This is sometimes called a cross joint.

Selection of the bond. When selecting a bond, consider both appearance and economy. Strength is not always a deciding factor as all types of bonds normally used will carry the expected loads. The type of bond usually depends on the type of brick, the color of the mortar, and the type of joint that is used. Different geometrical patterns are developed through the use of various bonds or combinations of bonds.

Colored Mortars

Colored mortar is sometimes used to add to the appearance of brick construction. Either all the mortar may be colored, or a deep rake between the brick is made and colored mortar is placed in the outer edge of the joint.

Structural Bonds

The three main types of structural bonds are the overlapping or interlocking of masonry units, the use of metal ties that are em-

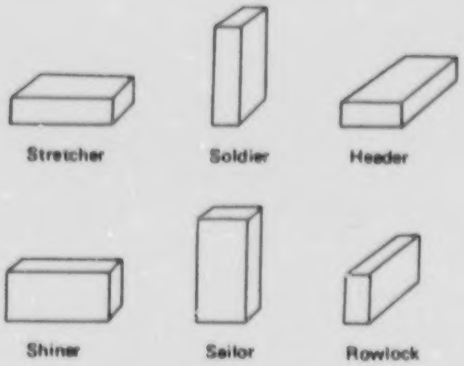

Stretcher
Soldier
Header
Shiner
Sailor
Rowlock

Figure 1. Brick Positions

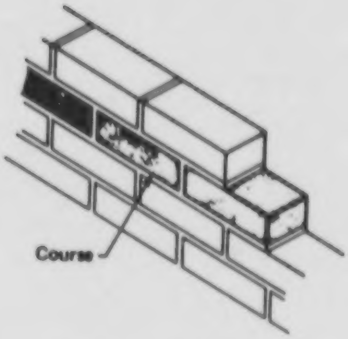


Figure 2. Brick Course

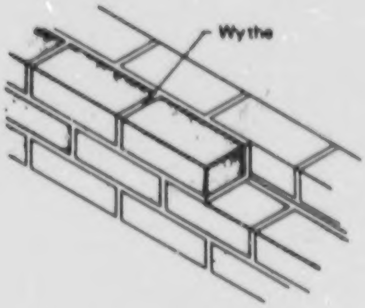


Figure 3. Masonry Wythe

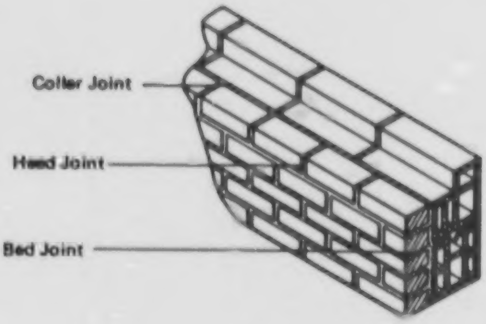

Collar Joint
Head Joint
Bed Joint

Figure 4. Masonry Joints

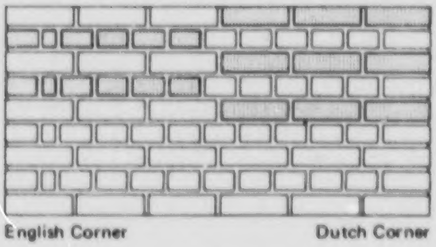

English Corner
Dutch Corner

Figure 5. English Bond

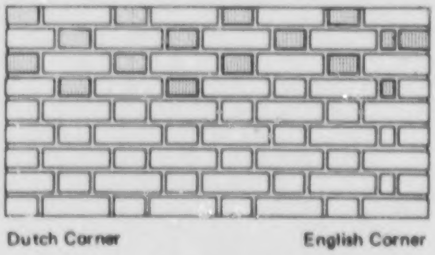

Dutch Corner
English Corner

Figure 6. Flemish Bond

bedded in connecting joints, and the adhesion of grout to adjacent wythes of brick. The overlapped bond uses variations of two basic methods of bonding. The English bond (fig. 5) consists of alternating courses of headers and stretchers. The Flemish bond (fig. 6) consists of alternating headers and stretchers in each course and arranging them so that the headers and stretchers in every other course appear in vertical lines. The stretchers are laid with the length of the wall and develop longitudinal bonding strength. At the same time, the headers are laid across the width of the wall, and this bonds the wall transversely. Most building codes require that masonry-bonded walls be bonded so that no less than 4 percent of the wall surface is made up of full-length headers. The distance between adjacent full-length headers should not exceed 24 inches either vertically or horizontally.

When masonry walls are bonded with metal ties, they may be used in both cavity-wall and solid-wall construction. Building codes usually permit the use of rigid steel bonding ties in solid walls. They normally require that the steel ties have a diameter of 3/16 inch and that they are spaced so that there is at least one metal tie for every 4 1/2 square feet of wall area. The vertical distance between ties should be not more than 18 inches and the horizontal distance not more than 36 inches. Ties that are in alternate courses must be staggered.

Another way of structurally bonding solid and reinforced brick masonry walls is by pouring grout into the cavity or collar joint between wythes of masonry. The grout core in reinforced masonry construction is also useful in containing and bonding the reinforcing steel. Grout may be defined as mortar with sufficient water added to allow the material to flow without segregation of the ingredients.

Pattern Bonds

Sometimes structural bonds may be used to create patterns on the face of a structure, but pattern usually refers to the arrangement of the texture or color that is used in the face. This way it is possible to secure several patterns in the same structural bond. Patterns may also be created by the method of handling the mortar joint or by the recession or projection of some of the bricks from the face of the structure.

The five basic structural bonds that are in wide use today and that create individual patterns are the running bond, common or American bond, Flemish bond, English bond, and stack bond (fig. 7).

Running bond. The least complicated of the basic pattern bonds is the running bond, and it consists totally of stretchers. Because there are no headers, metal ties are normally used. This bond is used most commonly in cavity-wall construction and veneered walls of brick although sometimes it is used in facing tile walls where the bonding is accomplished by very wide stretcher tile.

Common or American bond. The common or American bond is a variation of the running bond in that it has a course of full-length headers at regular intervals. These headers are used to provide both structural bonding as well as pattern. With this bond, header courses usually appear at every fifth, sixth, or seventh course. When using the common bond, a three-quarter brick must start each header course at the corner.

Flemish bond. When the Flemish bond is used, each course of brick is made up of alternate stretchers and headers, and the headers in alternate courses are centered over the stretchers in the intervening courses. There are several ways to vary the Flemish bond. Sometimes the number of stretchers between headers in each course is increased. If three stretchers alternate with a header, the resultant bond is called a garden wall because it was originally used in the construction of 8-inch garden walls. When two stretchers are used between headers, the result is a double stretcher garden wall. More stretchers may be used between headers when desired.

English bond. The English bond is composed of alternate courses of headers and stretchers. The headers are centered on the stretchers and the joints between stretchers in all courses line up vertically.

Dutch and English corners. There are two ways of starting the corners in Flemish and English bonds (fig. 8). The Dutch corner makes use of a three-quarter brick closure. The English corner may use a king or queen closure. When the queen closure is used, the 2-inch, or quarter, brick is placed 4 inches

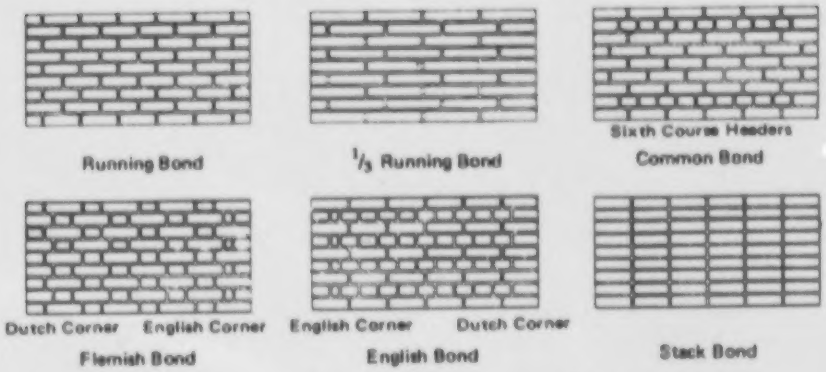

Running Bond
1/3 Running Bond
Sixth Course Headers
Common Bond
Dutch Corner
English Corner
Flemish Bond
English Corner
Dutch Corner
English Bond
Stack Bond

Figure 7. Common Structural Bonds

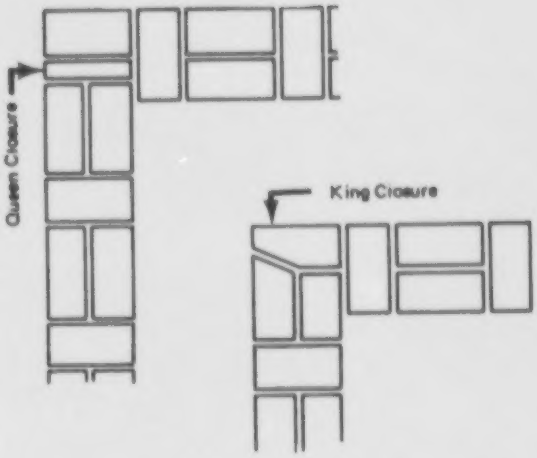

Queen Closure
King Closure

Figure 8. King and Queen Closures

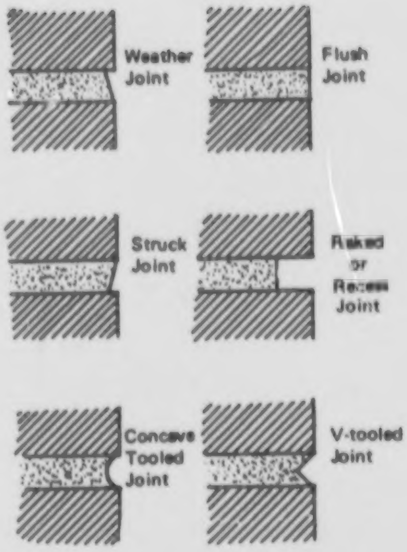

Weather Joint
Flush Joint
Struck Joint
Raked or Recess Joint
Concave Tooled Joint
V-tooled Joint

Figure 9. Types of Mortar Finishes

back from the corner. Sometimes the English corner is constructed by using a beveled brick called a king closure.

Stack bond. The stack bond is a pattern bond that has aligned vertical joints and no overlapping units. It is usually bonded to the backing with rigid steel ties. When there are large wall areas or when the construction is load bearing, steel pencil rods should be placed in the horizontal mortar joints.

Color and texture. Sometimes patterns are arranged through the use of different colored bricks. Interesting designs may also be created through the use of projected and recessed units.

Mortar Bonds

Mortar bonds and seals the units together, allows for dimensional variations, reinforces, and provides a means of decoration. Finishing may be done by the trowel or tool method. When the troweled joint is desired, the excess mortar is cut off or struck and finished with the trowel. The tooled joint requires the use of other special tools to compress and shape the mortar to the desired finish.

The concave joint and V-shape joint are usually kept fairly small and are shaped by a steel jointing tool. These joints resist rain penetration and are practical in areas where rainfall is heavy. The weathered joint is more difficult to shape because it must be worked from below. It is thought to be one of the best troweled joints because it also sheds water very easily. The rough cut, or flush joint is the easiest to accomplish because it is made by placing the edge of the trowel flat against the brick and cutting in any direction. The joint is not compacted, however, and a hairline crack will be left where the mortar is pulled away from the brick. This means that it is possible for water to seep into this crack. The struck joint is used quite often in ordinary brickwork and is made with a trowel. It does not shed water as well as some of the other types. The raked joint is made by removing the surface of the mortar while it is still soft, or uncured. It is very hard to make waterproof, and is not recommended where heavy rainfalls, high winds, or freezing may occur.

Exercise

1. What are stretchers?
2. What is a soldier brick?
3. Define **course.**
4. What is a collar joint?
5. What type of bond alternates courses of headers and stretchers?
6. How is grout used when structurally bonding solid and reinforced brick masonry walls?
7. List the five basic structural bonds that are commonly used today.
8. What two methods are used for finishing mortar?
9. What mortar joint is recognized as one of the best troweled joints?
10. What is a rowlock position of a brick?
11. What is a bed joint?
12. When the rough cut is used, and the mortar is pulled away from the brick, what is sometimes left at the mortar line?

G-2

Reinforced Brick

Objectives: *After completing this assignment, you will be able to—*

1. *list the types of stresses found in brick construction and how they affect the various parts of the structure;*
2. *discuss the materials that are used during reinforced brick construction; and*
3. *give the methods and procedures used when building or repairing a structure of reinforced brick.*

When a structure is subjected to greater than normal stress, reinforced brick construction must be used. Reinforced brick masonry is masonry consisting of brick, mortar, grout, and reinforcing steel. Tests are run to determine how much steel or reinforcement is needed and what type of construction will be necessary for the structure.

Masonry Stresses

Brick walls are usually subjected to compressive forces and to lateral forces. Compressive forces may be found in vertical loads that consist of the weight of the building, or dead load, and the weight of the contents, or the live load. These loads cause the walls to shorten or compress. Lateral forces include wind loads, earth pressures, and forces resulting from earthquakes. Stress is the resistance of a structure against a force.

Figure 1 shows the compression stress found in brick construction. The structure is subjected to vertical loads during this condition, and the complete unit has a tendency to be shortened. The ultimate strength of the structure depends mainly upon the compressive strength of the brick as well as the compressive strength of the mortar. The quality of work applied during construction also has an important effect on the strength of the structure.

Figure 2 illustrates the type of stress known as shear. This type of stress usually occurs when the wind is blowing against one of the walls.

Tension stress (fig. 3) occurs when applied loads tend to pull the brick units apart. Resistive measures depend on the composition of the mortar. Strengths may be increased by adding higher percentages of portland cement or increasing the water in the mortar mixture. When the brick is wetted before mortar is applied, the strength of the bond increases.

When weight is placed on a beam or wall that is supported at two or more points, the structure will bend to a certain extent. This type of structure is called a flexural member. Sometimes wind pressure against exterior walls also causes bending. When bending takes place, the stresses of compression and tension occur (fig. 4).

Materials

Steel is normally used in flexural members so that tensile and shearing stresses may be carried. Masonry materials are usually strong enough to withstand compressive stresses without additional reinforcement, but reinforcement steel must be placed where tensile and shearing stresses will occur.

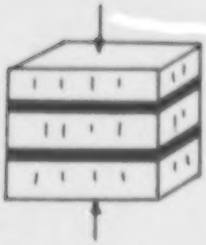


Figure 1. Compressive Stress

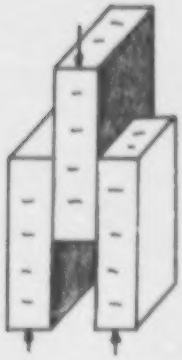


Figure 2. Shear Stress

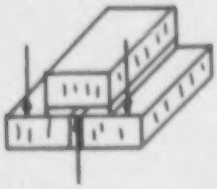


Figure 3. Tension Stress

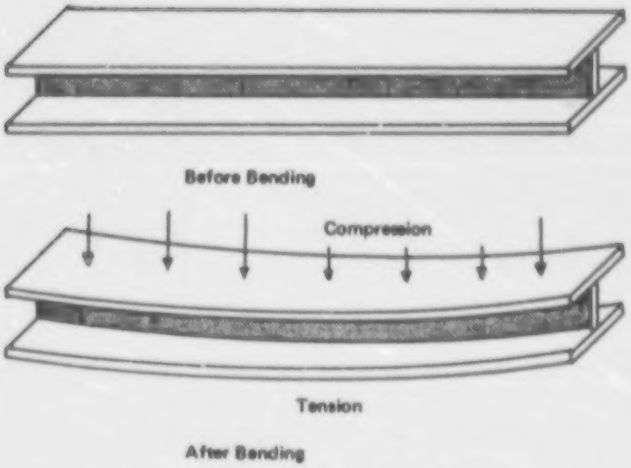

Before Bending
Compression
Tension
After Bending

Figure 4. Stresses During Bending

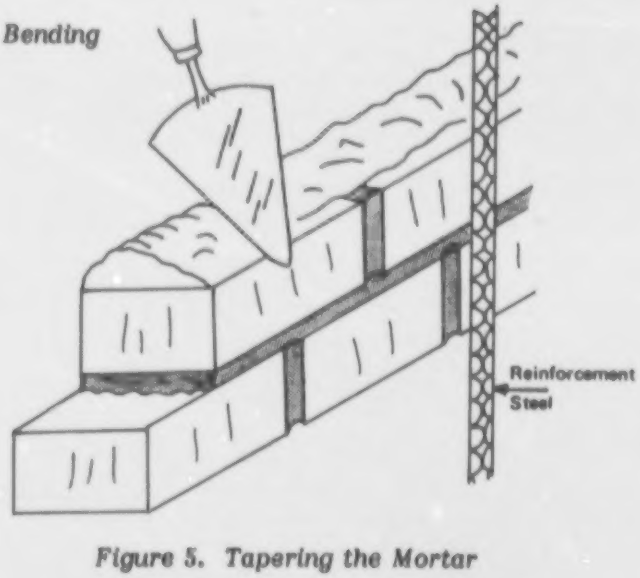

Reinforcement Steel

Figure 5. Tapering the Mortar

Reinforcement bars are placed parallel to the length or height of a flexural member in order to give tensile reinforcement, and bent bars or stirrups are placed at right angles to the length or height of flexural members to give shear reinforcement. Brick used in reinforced brick masonry is about the same as that used in standard masonry structures. As in other types of construction, high-suction brick must be wetted before mortar is applied.

Grout and mortar should meet standard specifications. The mortar should be mixed with as much water as can be used and still be a workable mixture. Two types of grout are normally used. Fine grout is used when the grout space is not over 2 inches in thickness; coarse grout is used for spaces thicker than 2 inches.

Reinforced Brick Construction

Vertical reinforcing steel is usually placed before construction begins. The steel should be securely tied in place and braced while construction proceeds. This prevents the steel from moving and causing the bond between the steel and mortar to be destroyed. Horizontal reinforcement rods may be placed in position as the job progresses. Both vertical and horizontal bars should be completely covered with mortar or grout.

During reinforced masonry construction, it is very important to completely fill all mortar joints. When joints are not filled, maximum bond and compressive and shearing strengths may be affected. Dry mortar should not be allowed to drop into the grout space at any time.

A tapered bed of mortar (fig. 5) should be used to prevent excess mortar from dropping into the grout space. This taper allows full bed joints, but prevents mortar from extending beyond the brick into the grout space. If excess mortar does protrude, but does not extend more than 1/2 inch over the grout space, it should be allowed to remain. Always completely fill the head joints between adjacent masonry units. This may be done easily by completely buttering the end of the brick to be laid with mortar. Sometimes a shoved joint is made. This means the brick is shoved against the next brick. This leaves the head joint full of mortar.

When grout is poured into the grout cavity, it should be sufficiently fluid so that it will flow into all joints and around all steel reinforcement rods. Grout can be put into the space by either low-lift or high-lift grouting. Low-lift grouting consists of building only a few courses and then pouring in the grout. High-lift grouting consists of building the wall much higher and then pouring in a great quantity of grout at one time. However, this latter method could cause a "blow-out." The fluid weight may cause the separate walls to spread, which would mean that the entire structure has to be rebuilt. Feeding small amounts of grout at one time allows the material to harden, and the danger of blow-out is lessened.

Always stir the grout before use to avoid having the aggregate separate. Grout should be poured with a spouted bucket and should not be allowed to splash onto the faces or tops of the brick. Because grout hardens more quickly next to the brick, the grout should be agitated immediately after it has been poured.

Exercise

1. What forces are brick walls subjected to?
2. What makes up the live load of a structure?
3. What is the definition for stress?
4. What happens when compression stress is applied to a structure?
5. What type of stress usually occurs when wind blows against a wall?
6. Why is steel normally used in flexural members?
7. What type of brick is used for reinforced brick masonry?
8. When should vertical reinforcing steel be placed in the structure?
9. What may be affected when all mortar joints are not filled?
10. How may the brick worker prevent excess mortar from dropping into the grout space?
11. Name two methods of placing grout into the grout cavity.
12. What should not be allowed to drop into the grout space at any time?
13. How is a shoved joint made?
14. How can you avoid "blow-out?"

G-3

Climatic Conditions

Objectives: *After completing this assignment, you will be able to—*

1. *discuss factors to consider when constructing masonry structures in rainy weather;*
2. *list problems associated with hot weather masonry construction;*
3. *discuss masonry problems due to cold and freezing weather; and*
4. *describe factors to consider when constructing masonry structures during windy conditions.*

The mason faces some problems that are not found in many occupations. If all conditions were right, masonry work would be much easier, but climatic conditions can ruin some jobs very quickly.

Rain During Construction

Most mortars and many masonry units contain materials that will dissolve when they come into contact with water. One is salt. If masonry is saturated with water after the structure has been erected but before curing has been completed, some of these salts will be dissolved. Dissolved salts are left on a wall or structure in the form of fine powder or stain. This deposit is known as efflorescence, and it will vary in color from white to green to brown. These salts can be removed, but it is easier to prevent their occurrence than to spend the time necessary to clean them. The easiest way to prevent efflorescence is to keep water off the brick or stone structure after it has been built and while it is curing. If the masonry structure becomes saturated with water during a rainstorm, it sometimes takes weeks to dry out, and efflorescence is likely to take place during this drying time.

After each work period when workers are away from the building site, all exposed tops of unfinished materials should be covered with waterproof material that is securely weighted and overhangs on each side. This takes very little time and may save hours of cleaning at a later date.

Hot Weather During Construction

High or dry temperatures can causes poor bond strength. They can also affect the compressive strength of the mortar. High temperatures can cause the water in the mortar to evaporate, leaving the mortar stiff and hard to apply. This cuts down on the time for spreading and placing the units into their proper locations.

When the mason works on hot, dry days, masonry units should be kept in a cool location until time to begin laying them. Lime added to the mortar has a tendency to slow the drying out process, but it is often necessary to add water to the mixture to replace the moisture being lost through evaporation. If the weather is extremely hot, smaller batches should be made to keep curing from beginning before the mortar has been applied to the structure.

Cold Weather During Construction

Leaky, chipped, and cracked masonry structures can often be traced to the freezing of mortar before it has set or to a lack of protection from cold weather during construction. Job specification sheets usually give instructions for protecting masonry during cold weather. There are several ways to keep the material from freezing. For instance, a portion or all of the structure may be covered with plastic sheets, and some type of heating device may be used to apply heat inside the enclosure. If this is done, be sure that no fumes are trapped inside. Ideally, the mortar should not be exposed to freezing weather for about 48 hours after it has been mixed. Masonry units that are laid in cold weather should be kept dry until they are placed in the mortar.

Now that it is possible to keep structures from freezing during the construction process, the mason can work through many of the winter months in the northern states. This was impractical several years ago.

Wind During Construction

Windy conditions during hot weather can cause rapid evaporation and support problems. To offset moisture loss, extra water should be added during mixing. If there is a high wind, or sudden gusts of wind, some types of support should be erected. Usually braces placed against the wall at about 45 degrees will give sufficient support. Internal reinforcement will also help resist wind forces.

Exercise

1. What is the condition that takes place when salts dissolve and leave a residue on masonry materials?
2. What is the easiest way to prevent efflorescence?
3. How does heat affect mortar used during construction?
4. Why may lime be added to mortar on hot, dry days?
5. What may cause leaky, chipped, and cracked masonry?
6. How long after mixing should mortar not be exposed to freezing weather?
7. What can windy conditions during hot weather cause in mortar?
8. What can be done to keep high winds or sudden gusts from damaging a wall under construction?

G-4

Preparation of Materials

Objectives: *After completing this assignment, you will be able to—*

1. *give the essentials necessary to produce quality construction in the masonry trades;*
2. *discuss the steps to prepare masonry for construction;*
3. *describe ideal mortar properties; and*
4. *discuss the steps to take in the preparation of mortar.*

Essentials for Quality Construction

Masonry that resists rain penetration, holds loads it is designed to withstand, and lasts under all types of conditions depends upon a great number of elements. When some of the necessary elements are missing, the construction will suffer. A poor masonry job causes many problems and may even be dangerous to individuals working in or around the structure.

A wall design that prevents the concentration of moisture within the masonry must be used. Haphazard designs may ruin the job when all other elements are superior. Materials should conform to the requirements of standard specifications of the American Society for Testing and Materials. High-suction brick or stone should be wetted down before beginning the lay-up process. Insufficient wetting affects the bond and weakens the structure.

It is also very important that the correct mortar be selected for the material being used and for the structure being built. The mortar should be mixed with as much water as possible and still be capable of making a good bond. Oversanding, which will weaken the entire structure, should be avoided. All joints should be filled with mortar, and no openings should be left between vertical or horizontal masonry. Expansion joints should be positioned and installed properly.

Masonry workers should protect their materials during construction. Because curing takes some time, strong waterproof materials should be placed over the partially constructed structure until it has cured. Plywood and other wooden materials do not sufficiently deflect direct moisture. Flashing and adequate weep holes should be provided to allow drainage from within the masonry structure. When it is necessary to lay masonry during cold weather, precautions must be taken to protect the structure from freezing until proper curing has taken place.

Preparation of Masonry

Strength and resistance to the penetration of rain in masonry walls depend essentially on the completeness and strength of the bond between the masonry units and the mortar used. There must be enough water in the mortar to develop a bond. If the mortar does not contain enough water, the bond will be weak and spotty. When a brick or stone is placed in water, the water rises or is absorbed into the material in a manner similar to the rise of liquid in a growing plant. This capillary action varies considerably with different bricks and stones. The amount of water by weight that enters 1 square inch of the brick's surface in 1 minute when the surface is immersed in 1/8 inch of water is known as the brick's initial rate of absorption or suction.

High-suction bricks, especially under dry conditions, will absorb water from the mortar before the bond has been completed, and a poor bond will result. For this reason, these bricks must be soaked thoroughly and then allowed to surface dry before they are laid. No mortar water will escape into a brick that already contains moisture.

Mortar Properties

Mortar must be plastic enough to be easily worked with a trowel. The properties of mortar are tied closely to the type of sand it contains. Clean, sharp sand makes the best mortar. If you add too much sand, the joint will be weak, the mortar will drop off the trowel, and it might allow moisture to seep through after it has cured. If the proper grade of sand is used, the mortar will be more workable.

A mortar's water retention is important so that both plasticity and a good bond are attained. Strength and durability must be considered when mixing mortar. If the structure will be subject to heavy loads or other stresses, selecting a correct mixture is important. Bond is the property of the mortar to hold the units of masonry together.

Preparation of Mortar

A large amount of mortar should be mixed in a drum-type mixer similar to regular concrete mixers. At least 3 minutes of mixing time are necessary. Always mix all dry ingredients first before adding water.

Mortar is often mixed by hand in a mortar box or similar device. However, with this method, more care must be taken; it is more difficult to mix the ingredients thoroughly. A supply of water in a drum or from a hose should always be available for adding to the mortar as necessary. Always be sure the water is clean and free from salts, foreign materials, and minerals. If mortar has partially set before it is ready for use, it should be discarded. Remixing can be done up to this point.

Do not use antifreeze materials in a mix. If enough antifreeze is added to stop the freezing process, it will also weaken the mortar.

Exercise

1. To what standards and specifications should masonry materials conform?
2. What will insufficient wetting of brick or stone cause?
3. What is a brick's initial rate of absorption or suction?
4. What does oversanding cause?
5. How much water should be placed on high-suction bricks before they are laid up?
6. What type of sand makes the best mortar?
7. What is bond?
8. In what condition should the ingredients be for the first mix?
9. What type of water should be used to mix into mortar?
10. Why should antifreeze materials not be used in a mix?

H-1

Types of Brick Walls

Objectives: *After completing this assignment, you will be able to—*

1. *discuss the use of bearing walls in structures and*
2. *identify the various types of exterior walls and their specific uses.*

Building Requirements

Certain elements must be considered before any wall is constructed. One is whether the building is for human occupancy or for storing materials. Climatic conditions must also be studied. The locality may be subject to a great amount of heat, freezing weather, rain, snow, or heavy winds. Another consideration is that the various vertical or lateral loads may require more reinforcement than is necessary in other types of construction.

Buildings usually have two types of basic structural designs: wall-bearing and skeleton frame. In a wall-bearing building, the interior and/or the exterior walls support the vertical loads that are transmitted to them. Together with the floors and roof, they also withstand lateral forces. In a skeleton-frame construction, a framework of steel and beams support the vertical loads. This framework works in combination with the exterior and interior walls to resist lateral forces.

Contemporary Bearing Walls

The contemporary bearing wall is a popular construction design. It is economical and uses both the walls and floors to resist lateral forces. There are two basic types of contemporary bearing walls. In one, vertical loads are carried by the exterior walls and the interior walls parallel to the exterior walls. Corridor walls may also be used to carry this load. In the other, vertical loads are carried by interior cross walls. Both types of walls may be used when necessary or convenient. The contemporary bearing wall is much thinner than the walls that were used 60 or 70 years ago. While more brick is used in this type of construction, buildings using these walls can be built at less cost than those using skeleton-frame designs.

Exterior Walls

The weather must be considered when building a structure. Wind may drive rain into very small openings in brick walls, and if this water freezes, the resulting expansion may break the material apart. Two main methods of combating the penetration of wind-driven rain into the masonry are (1) by constructing channels behind the exterior wythe to conduct water to the outside and (2) by providing a barrier to water penetration behind the exterior wythe. The channel design is used with brick veneer, SCR brick, hollow walls, and cavity walls. The barrier design is found in reinforced brick and metal-tied walls. Drainage-wall designs are recommended for use where the locality is subject to severe weather. Drainage or barrier walls may be used in areas of moderate exposure, and where the locality is subject only to

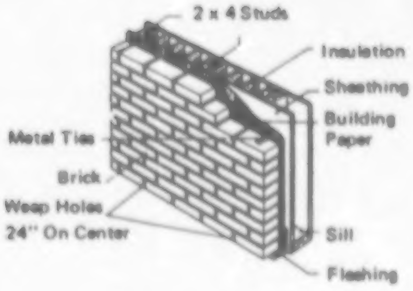

2 x 4 Studs
Insulation
Sheathing
Building Paper
Metal Ties
Brick
Weep Holes 24" On Center
Sill
Flashing

Figure 1. Brick-Veneer Wall

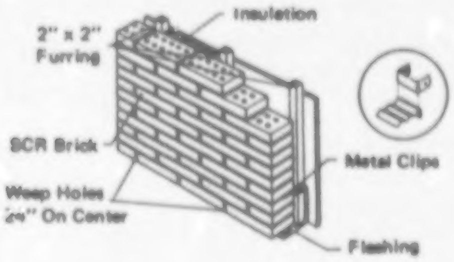

Insulation
2" x 2" Furring
SCR Brick
Metal Clips
Weep Holes 24" On Center
Flashing

Figure 2. SCR Brick Wall

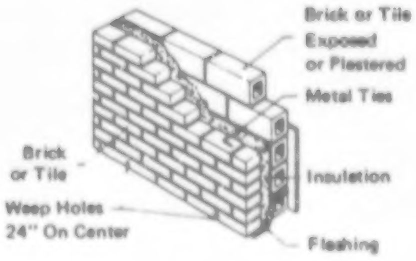

Brick or Tile Exposed or Plastered
Metal Ties
Brick or Tile
Insulation
Weep Holes 24" On Center
Flashing

Figure 3. Cavity Wall

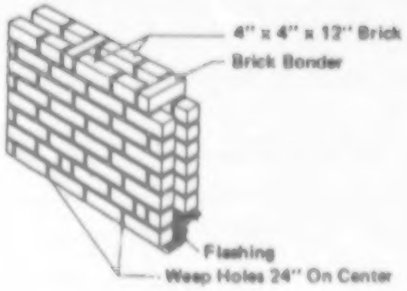
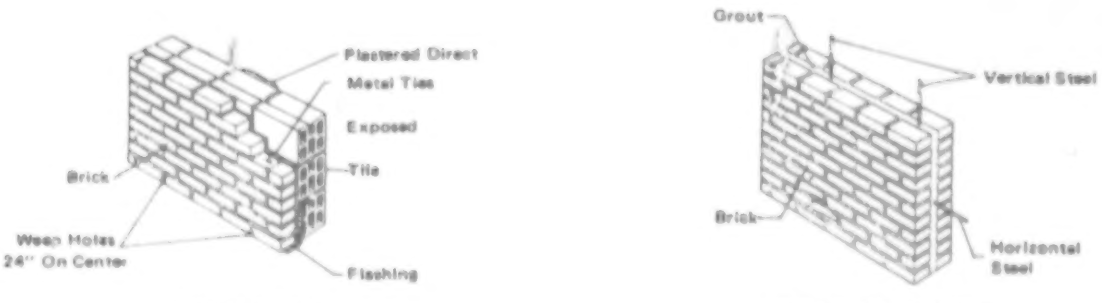

4" x 4" x 12" Brick
Brick Bonder
Flashing
Weep Holes 24" On Center

Figure 4. Masonry-Bonded Hollow Wall


Plastered Direct
Metal Ties
Exposed
Tile
Brick
Weep Holes 24" On Center
Flashing
Grout
Vertical Steel
Brick
Horizontal Steel

Metal-tied Wall

Reinforced Brick Masonry

Figure 5. Barrier Walls

slight exposure, conventional masonry could be used.

Brick-veneer walls. The brick-veneer wall is normally used in residential construction in conjunction with frame construction. The weight of the brick veneer is held by the foundation of the structure, and the brick is usually fastened to the wood frame by corrugated metal ties (fig. 1). The ties are fastened to the studs with 8d nails. Weep holes are left in the brick course slightly above the flashing at the base. A head joint should be left out at intervals of about 2 feet in order to allow for the weep hole. When brick veneer is used with frame construction, the height of the brick veneer should not extend more than 30 feet above the foundation. The wood frame must carry all loads, and the veneer should not be used to support the structure.

SCR brick walls. The SCR load-bearing wall is made of a 6-inch, through-the-wall unit to which 2-by-2-inch furring strips and interior finishes are added (fig. 2). Clips may be used to attach the 2-by-2-inch furring strips. This type of external wall is economical, especially for one-story structures, and through proper construction is highly resistant to the water penetration. This wall may also be used as an economical load-bearing partition. When it is used for this purpose, one side may be left exposed and wallboard or plaster applied to the other side.

Cavity walls. The cavity wall has a very high resistance to rain penetration. The interior wythe may be exposed brick, glazed tile or other masonry units, or plaster or wallboard finish applied directly without furring (fig. 3). Water-repellent vermiculite and perlite (plastic granules) may be used for insulating cavity walls, and they are poured directly into the cavity during construction. Weep holes must be left in the bottom of the cavity in order to drain the moisture that may penetrate the outer wythe. These holes must be kept open, mortar must not be allowed to drop into the cavity. Mortar fins made by excess mortar in the bed joints should be trimmed off or spread as plaster on the inside of the cavity.

Masonry-bonded hollow walls. The masonry-bonded hollow wall has an overall thickness of 12 inches (fig. 4). A utility brick, which is 4 inches by 4 inches by 12 inches, makes a strong, economical wall. This type of wall has greater lateral strength than the metal-tied cavity wall. Header units should be placed every two feet on center horizontally and from 20 to 24 inches vertically. An 8-inch closure unit must be used in the horizontal bonding course to maintain a 1/3 brick bond. Weep holes must be provided in all courses just above the flashing.

Barrier-walls. Barrier walls may be either metal-tied or reinforced brick (fig. 5). The metal-tied wall is made entirely of brick or other masonry units. Eight inch metal-tied walls have a greater resistance to rain penetration than 8-inch masonry-bonded walls when the collar joints in the metal-tied walls are filled solidly with mortar.

Reinforced walls. The reinforced wall has already been discussed in a previous assignment, but remember that this wall has a high resistance to lateral forces or vertical loads that are applied off-center. These walls are used universally for storage tanks, retaining walls, or for high walls that can be built more narrowly when reinforcement is used.

Solid brick walls. Solid brick walls (fig. 6) do not contain backing materials of wood, stone, or concrete blocks. They have no hollow spaces between brick layers. Because solid brick walls are normally used for inside walls, no flashing or weep holes are built in to remove water. These walls are recommended for fire walls, interior load-bearing walls and partitions, and exterior walls in localities where rain is not accompanied by high winds.

Exercise

1. What basic factors should be considered when choosing the type of wall construction to use?
2. What are the two types of basic structural designs for buildings?
3. What are two advantages of contemporary bearing walls?
4. Give the two methods used to combat penetration of wind-driven rain into exterior walls.
5. What type of wall should be constructed in a locality with severe weather?

6. What type of wall is usually used for residential construction?
7. Why should head joints be left out of brick-veneer walls at intervals of 2 feet?
8. What are used to attach 2-by-2-inch furring strips in the SCR brick wall?
9. What may be used for insulating cavity walls?
10. What is the overall thickness of a masonry-bonded hollow wall?
11. What are two types of barrier walls?
12. Name the uses of solid brick walls.

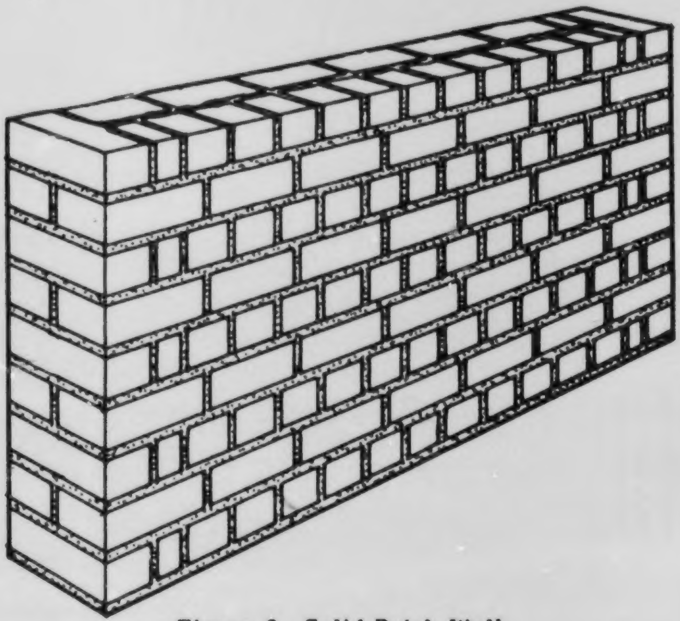


Figure 6. Solid Brick Wall

H-2

Construction of Brick Walls

Objectives: *After completing this assignment, you will be able to—*

1. *discuss the procedures used in setting a line and laying to it;*
2. *give the procedures used in raising a corner lead; and*
3. *give the steps to use when making mortar joints.*

Setting the Line

In order to have a neat job, the horizontal joints should be parallel to each other. This is done by laying the outside tier of each course of brick to the line. The line should be small, but should have enough strength. Most masons use nylon cord. The line should be stretched tightly between the corners and fastened by nails. The nails are flattened at the end when used with close joints so that they will fit in the vertical joints of the face of the wall. If the line is so long that it sags, it must be held up in the center by a trig. The trig should never be fastened to the line, but should be in the form of a loop so that the line may be drawn through it with ease. A broken line should be spliced rather than knotted. A knot pushes the line out from the wall, and the loose ends may get in the mortar.

The corners, or leads, are built up first and carefully plumbed with a level and plumb rule. The line should be stretched between these two corners and raised only one course at a time. Leads are usually not carried more than a header ahead of the work because the wall will have a tendency to be irregular. While the courses are being laid between headers, the leads may be secured to the next header course. The trig also should not be carried up more than two courses over the line and should be sighted both for height and for distance from the face of the wall. Care should be taken to fasten the line at the corners to courses of the same height.

Laying to the Line

Brick should never be laid directly against the line. The top edge of the brick should be even with the line and about 1/8 inch behind it. Crowding the line or pushing the brick against it may throw the line out of position and the wall may bulge or be uneven. The biggest problem for inexperienced masons occurs when they hit the line with the trowel during the mortar-spreading operation. When laying the brick, the fingers should come toward the line and then be lifted so that they come up as the brick goes down on the mortar bed. If the thumb goes near the line, it should be lifted as the brick is placed into position. The brick should be squeezed into place with the trowel.

Raising a Corner Lead

Because the corner, or lead, is the first part of the wall to be laid, it determines the width of the mortar joint both horizontally and vertically for the rest of the wall. Sometimes trial courses are laid without mortar to secure correct measurements. The blueprints

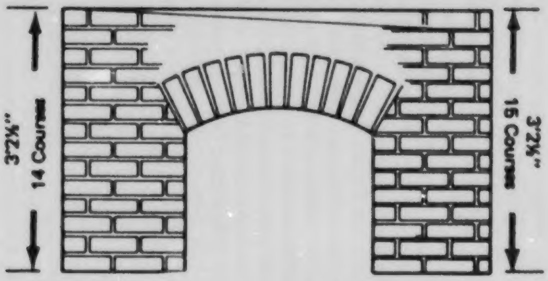

3'2¼"
14 Courses
3'2¼"
15 Courses

Figure 1. Hog in the Wall

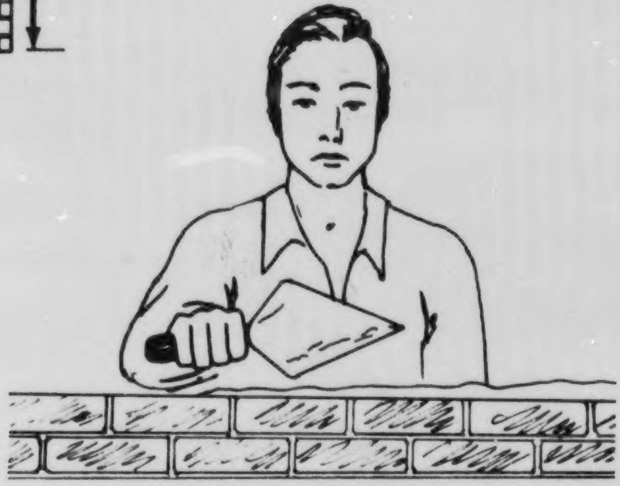


Figure 2. Windrowing Mortar

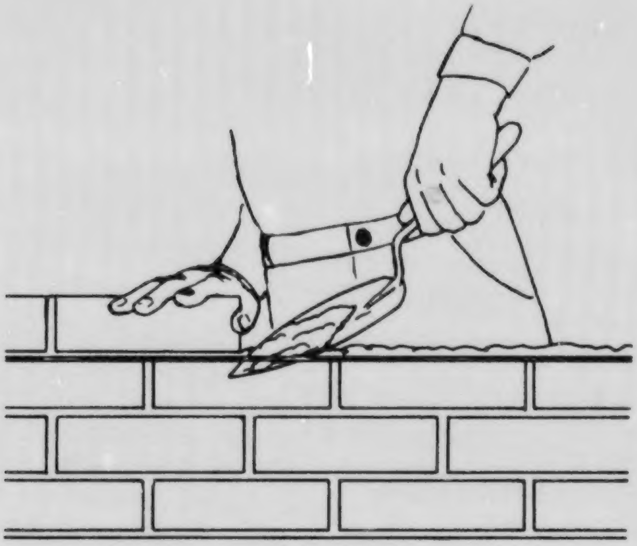


Figure 3. Cutting Off Mortar

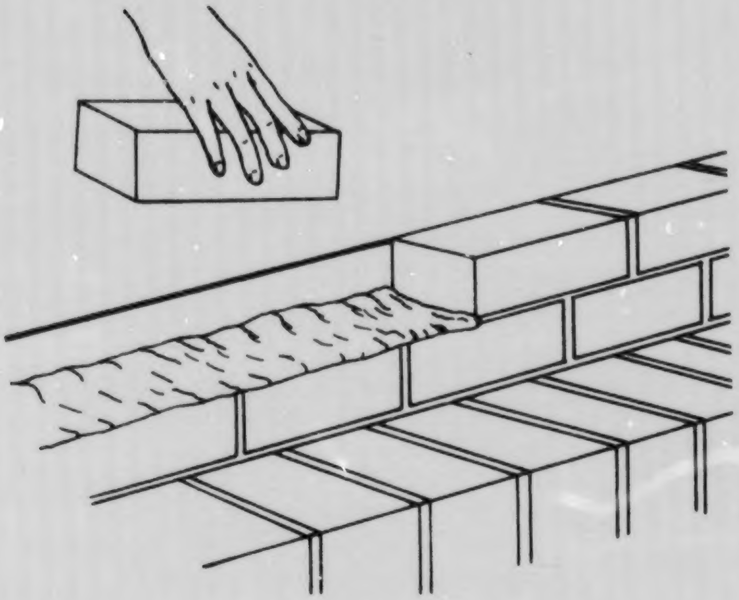


Figure 4. A Bed Joint Furrow

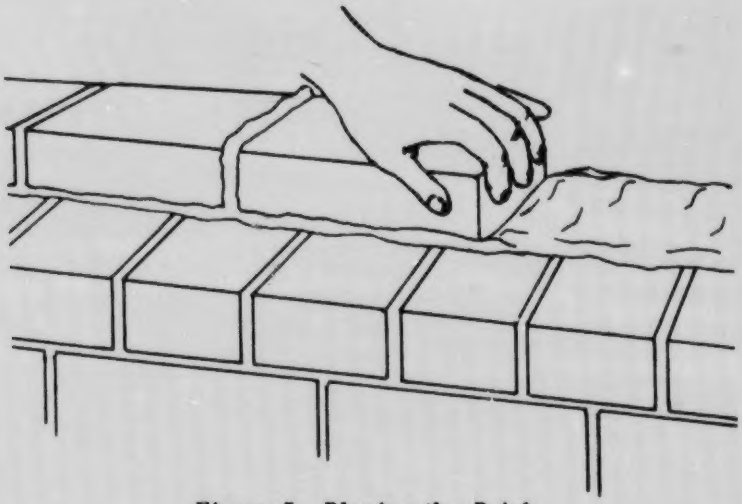


Figure 5. Placing the Brick

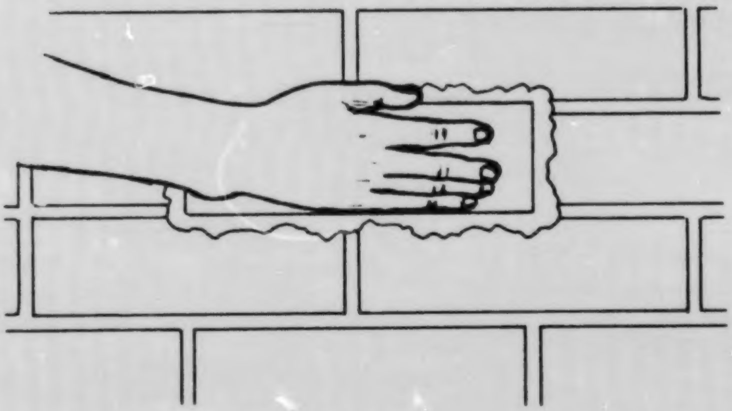


Figure 6. Inserting a Brick into a Wall

and specifications of the structure usually define the length of the wall, the bond, and the joint. A slight variation in the width of an end joint will allow the bricklayer to make the bonds come out correctly without having to use closers except at the corners.

The number of courses necessary to attain sill height, window-head height, story height, or other heights is usually marked off on a story pole or other measuring device. The level should be used for leveling the wall horizontally and as a straight edge on the face of the wall. After the first few courses are laid, the wall may be plumbed vertically. The lead should not be extended too far from the corner. The usual distance is 4 feet. If you are working on the corner, you should have a start on the other masons, and you may have to back up on your part of the wall, while the other masons are building to you. You should measure your courses often enough to secure the correct thickness of the joint.

Both sides of a corner should be plumbed. The plumb rule should be held vertically against the wall close to the corner and used this way on both sides of the wall.

The term **hog in the wall** means two opposite corners or leads that have reached a certain height in the same measurement, but differ in their number of courses (fig. 1). This problem occurs most often when building arches, bricking between openings, and constructing long walls. Once this mistake has occurred, it is difficult to remedy. Although it may be corrected by increasing the bed-joint thickness on one side and decreasing it on the other, this is not a good practice and may be very noticeable. It is better to redo the incorrect lead. Because this is a costly error, precautions should be taken as the job progresses, and frequent measurements should be taken.

Mortar Joints

If you are right-handed, you should pick up mortar with the left edge of the trowel. A full load on a large trowel is usually enough mortar for five bricks. Holding the trowel with the left edge over the centerline of the course, tilt the trowel to the right until it is empty. This drops a windrow of mortar along the wall (fig. 2). Any mortar projecting over the edge of the wall is cut off with the trowel edge (fig. 3). The cut off mortar is returned to the mortarboard.

The mortar should be spread about 1 inch thick for the bed joint with a shallow furrow made in the center of the bed (fig. 4). The brick, with mortar placed on the end, is then pushed into place so that excess mortar squeezes out at the head joint and at the sides of the wall (fig. 5). The excess mortar is cut off and used for the next end joint.

Sometimes it is necessary to insert a brick in a wall. Spread a thick bed of mortar into the opening, then shove the brick into the opening. The mortar should squeeze out on all sides (fig. 6). Cut off the excess and return it to the mortarboard.

Cross joints in header courses are made by filling the joints with mortar, placing mortar on the side of the brick, shoving the brick into position, and then removing the excess mortar. These steps are shown in figures 7A and 7B. Closure joints in both header and stretcher courses are made the same way.

Pointing is done immediately after the wall has been laid. This consists of filling exposed joints with mortar. Often, holes and defective mortar joints show up and must be pointed. A pointing trowel is used for this purpose.

Joint Finishes

Joints must be finished to make the structure more waterproof and to improve the overall appearance. There are a number of joint finishes, as shown in figure 8. If the joints are cut flush with the brick and not finished, cracks between the mortar and brick usually appear. Finish the joints before the mortar has hardened. Jointing tools are discussed in the assignment concerning tools near the front of this manual.

Exercise

1. What should be used when setting a line to prevent the line from sagging?
2. How many courses should the line be raised at one time?
3. How far from the line should a brick be laid during construction?

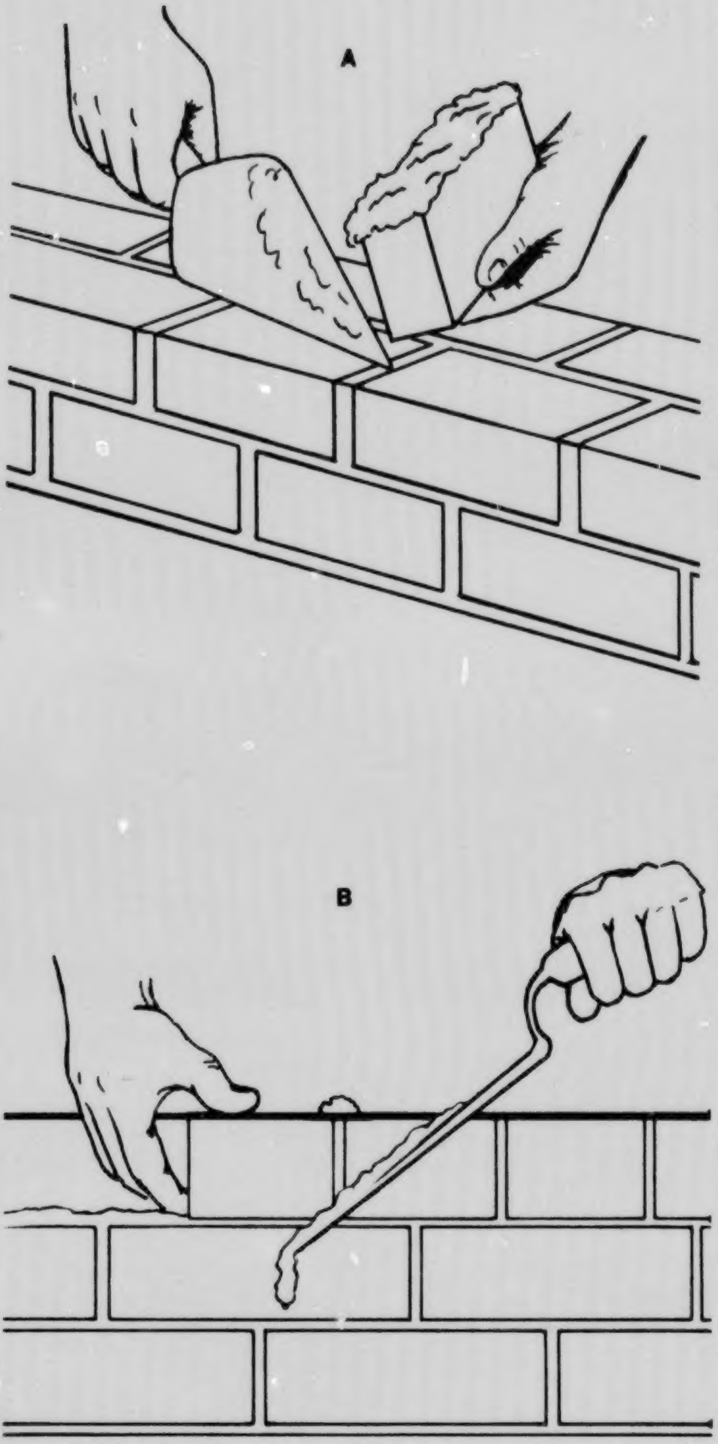


Figure 7. Laying Up a Cross Joint in a Header Course

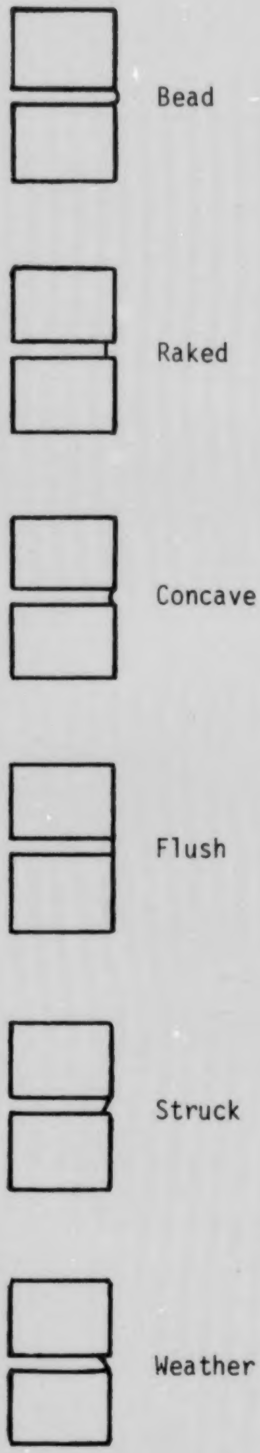

Bead
Raked
Concave
Flush
Struck
Weather

Figure 8. Types of Joint Finishes

4. What determines the width of the mortar joint both horizontally and vertically for the rest of the wall?
5. How far is the lead usually extended from the corner?
6. What does the term **hog in the wall** mean?
7. If you are right-handed, how should you pick up mortar?
8. What should be done with any mortar that projects over the edge of the wall after application?
9. How thick should mortar be spread on the bed joint?
10. What should be made in the center of the bed joint before the brick is inserted?
11. When is pointing done?
12. Why should joints be finished?

H-3

Construction of Rubble Stone Walls

Objectives: *After completing this assignment, you will be able to—*

1. *list the guidelines for constructing rubble stone walls and*
2. *discuss the procedures for laying a rubble stone wall.*

Guidelines for Laying Rubble Stone

Although laying a brick wall is similar to laying a stone wall, there are some steps that differ. Each stone should always be placed on its broadest face, usually with the larger stones laid in the lower courses. As the wall becomes taller, stone size should decrease. Always wet any porous stones before they are placed in the mortar bed. Failure to do so will result in the stone's absorption of water from the mortar. This will weaken the bond between stones.

The spaces between stones should be as small as possible and the spaces should be completely filled with either mortar or small stones.

Footing stones should be larger than the rest of the wall to help relieve the possibility of unequal wall settlement. They should be placed in a mortar bed about 2 inches deep. Regular bedding joints may vary in thickness, depending upon the size of the stone. As with brick, do not spread the mortar too far ahead of the stonelaying operation. This sometimes allows the mortar to become too dry to complete a good bonding job. Head joints should be made after three or four stones have been laid, and formed before the mortar in the bed joint has set up.

Bonding stones should be placed at least once in each 6 to 10 square feet of wall. A bonding stone projects completely through the wall, as shown in figure 1. Each head joint should be offset from adjacent head joints above and below it when possible, as shown in the random rubble wall in figure 2.

Laying a Rubble Stone Wall

If it is not necessary for the wall to be exactly plumb and true to the line, the level and line will not have to be used. In this case, the wall is laid by eye, but frequent sightings must be taken.

If the wall must be exactly plumb and true to the line, corner posts of wood should be erected to act as corner leads. A line is then attached to the leads and the stone is laid to that line. Random rubble stone is not laid in courses, as shown in figure 2. Figure 3 gives an example of how a coursed rubble stone wall should look. In both examples, some parts of the stone will be farther away from the line than other parts.

Extreme care should be taken when building structures from rubble stone, as the units are much heavier. The extra weight can not only cause back strains, but also make it easier to get finger and hand bruises. Take care that you do not drop the stones and wear hard-toed shoes when doing this type of work.

Finishing operations are very similar to that done in bricklaying. If staining is not desired, a nonstaining white portland cement should be used when making mortar.

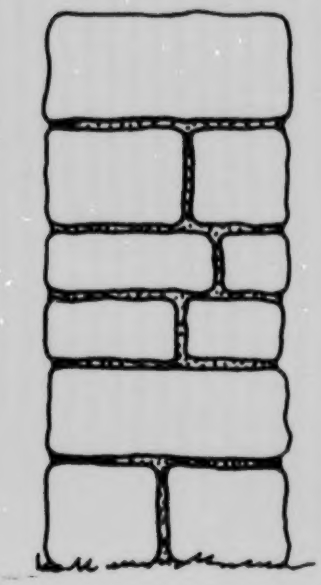


Figure 1. Bonding Stones

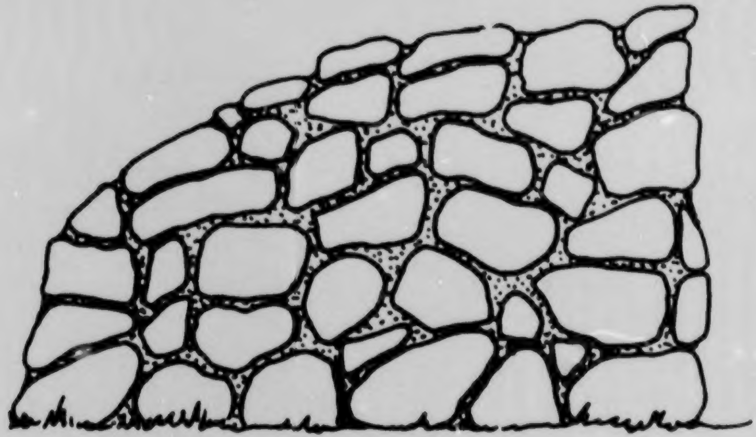


Figure 2. Random Rubble Stone Construction

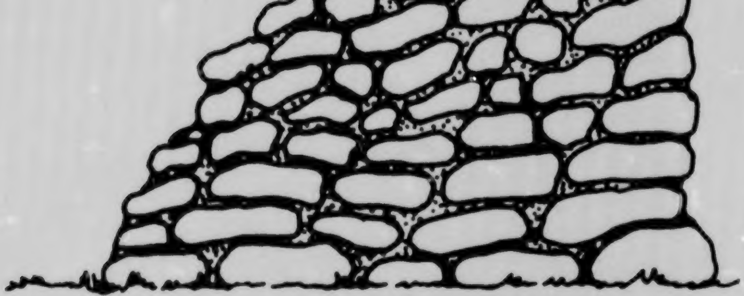


Figure 3. Coursed Rubble Stone Construction

Exercise

1. How should each stone of the wall be placed?
2. What size stones should be placed in the lower courses or lower part of the wall?
3. What happens if porous stones are not wetted before placement?
4. How large should footing stones be?
5. How deep should a mortar bed be for footing stones?
6. How many stones are laid before head joints are made?
7. How often should bonding stones be placed in a wall?
8. How far does a bond stone project into the wall?
9. What does random rubble stone construction indicate in terms of construction?
10. What may the extra weight of rubble stone cause?
11. What should be done to prevent staining of the stone?

I-1

Footings

Objectives: *After completing this assignment, you will be able to—*

1. *discuss the types and uses of brick and concrete footings and*
2. *give the procedures to use in constructing brick footings.*

All foundations or bearing walls should rest on a footing, or base, that projects beyond the wall on each side and to a certain depth in the ground. If the soil is wet or soft, the footings may be made of reinforced concrete or steel beams encased in concrete. If the soil is reasonably firm and the building is a moderate size and weight, the footings may be constructed of concrete, stone, or brick. Footings are needed to distribute the weight of the structure over a larger area of bearing surface. This means that they diminish the pressure per square foot on the foundation bed and tend to lessen vertical settlement. Also, by increasing the area of the base of a structure, footings add to the structure's stability and form a protection against stresses that might throw it out of plumb. Most building codes require that foundation walls, piers, or basement walls have a footing at least 12 inches wider than the thickness of the wall or pier. Footings must also be below the frost line to prevent moisture expansion during freezing from lifting the structure.

Brick footings are not used in areas where moving soil will cause walls to buckle. Stone footings, larger than brick footings, keep the walls from deteriorating as easily and may be used if they are cheap and plentiful. Concrete and reinforced concrete are used most often because of their availability and adaptability. Column footings are usually made of concrete with rods and grillage for reinforcement. Chimney footings should be built with extreme care because there is a concentrated weight on a small area. The projections of the footings for chimneys can be determined only by the weight and height of each chimney.

Brick Footings

Although it is recommended that projecting courses of footings be laid with the brick on edge because of the added strength, most footings are constructed with the bricks laid flat. Two inches should be the maximum projection of one course beyond the one above it. If the projection is one course deep, all the brick forming the projection should be headers. If the projection is two courses deep, the top course should be constructed of all headers and the lower one of stretchers. If the footings are constructed of bricks that are laid flat, the first two courses should be of the same width, and each succeeding course should be decreased on both sides by 2 inches until the width of the wall is reached. It is very important that all bed joints be filled with mortar.

Construction of a Brick Footing

An 8-inch wall is commonly used in construction; therefore, the following procedures are based upon the dimensions of this size and

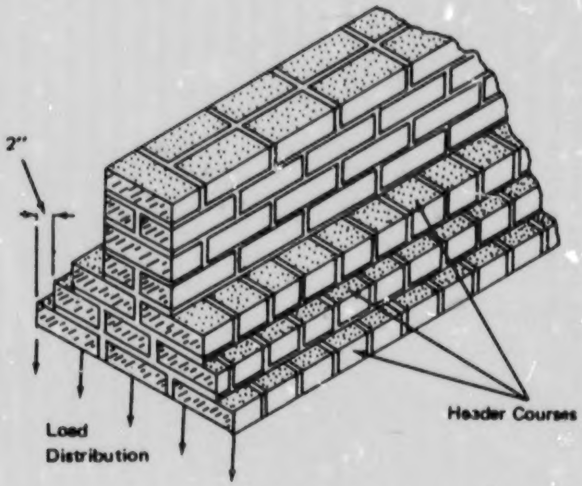

2"
Load
Distribution
Header Courses

Figure 1. Brick Footing for an 8-Inch Wall

type of wall (fig. 1). The soil upon which the footing is to be placed should always be level and smooth. First, the outside tier of the first course is laid out dry and the cross joints marked. The corner is started with a 3/4 bat so that the next course, which consists of headers, can be started with a full bond. The inside tier of the first course is laid out dry and the cross joints marked. The wall should be wide enough to allow for two headers when they are placed end to end. The first course of both the outside and inside tiers are then laid in mortar. This course must be level, straight, and square. The center is filled with headers, and the inside and outside tiers are checked for trueness. The second course consists of a full header on both sides of the wall. When the third course is laid, it should be set back 2 inches on both sides of the wall. The 8-inch wall is then placed on top of the third course. Be sure it is centered on the footing so that compressive stress, or the load of the wall, will be centered on the footing.

Concrete Footings

Walls. Most building codes in the northern part of the United States require concrete footings to be at least 3 feet below the surface of the ground to be below the frost line. When the footing is not deep enough, freezing may cause buckling, shifting, and unsightly cracks to appear in the construction. The footings should project at least 6 inches beyond the width of the wall as well as one-third of the footing width in depth.

Piers, columns, and chimneys. Piers and columns that have excessive loads placed upon them require footings designed for the particular weight they are required to carry. The footings extend on four sides and usually are much deeper than those designed for walls.

Simple piers used for porches, girder supports, and stoops are normally designed to be the same size as the walls. The footings for columns of small buildings are usually about 3 feet square and 18 inches deep, unless there is an excessive amount of weight not normally found in that type of structure.

Chimney bases, or footings, are much heavier than those for walls because of the concentration of weight that they must support. The size of the footings varies according to the size of the chimney.

Exercise

1. What is the primary purpose of a footing?
2. How are column footings constructed?
3. What is the maximum projection of one course beyond the one above it during brick footing construction?
4. Why should the first course of a brick footing be started with a 3/4 bat?
5. Why do most building codes in the northern part of the United States require concrete footings to be at least 3 feet below the surface of the ground?
6. Describe the footings used for piers and columns.
7. How do chimney footings differ from wall footings?
8. Where are brick footings not used?
9. How large are footings for columns of small buildings?

I-2

Arch Types, Forms, and Terminology

Objectives: *After completing this assignment, you will be able to—*
1. *identify types of arches that are being built today and*
2. *define the terms used to describe arches and their parts.*

The Parts of an Arch

Masonry workers must know the terms used in arch construction (fig. 1) so they can interpret the blueprints they will use. The following are the more common arch terms.

Abutment—the skewback and the masonry that supports it

Arch—a form of construction in which a number of units span an opening by transferring vertical loads laterally to adjacent units and onto the supports; usually classified by the curve of its intrados

Arch axis—the median line of the arch ring

Camber—the relatively small rise of a jack arch

Constant cross-section arch—an arch whose depth and thickness remain constant throughout the span

Creepers—the bricks in the wall adjacent to the arch that are cut to conform to the curvature of the extrados

Crown—the apex of the arch ring; in symmetrical arches the crown is at mid-span

Depth—the dimension that is perpendicular to the tangent of the axis; the depth of a jack arch is taken to be its greatest vertical dimension

Extrados—the convex curve that bounds the upper extremities of the arch

Fixed arch—an arch whose skewback is fixed in position and inclination; plain masonry arches are fixed arches

Gothic or pointed arch—an arch with a high rise and sides consisting of arcs of circles with centers at the level of the spring line; sometimes referred to as a drop, equilateral, or lancet arch, depending on whether the spacings of the centers are less than, equal to, or greater than the clear span

Intrados—the concave curve that bounds the lower extremities of the arch; differing from a soffit in that an intrados is linear and the soffit is a surface

Jack arch—a flat arch

Keystone—the center unit that wedges the arch in place

Multicentered arch—an arch whose curve consists of several arcs of circles that are normally tangent at their intersections

Rise—of a minor arch, the maximum height of the arch soffit above its spring line; of a major parabolic arch, the maximum height of the arch axis above its spring line

Segmental arch—an arch whose curve is circular, but less than a semicircle

Semicircular arch—an arch whose curve is a semicircle

Skewback—the inclined surface on which the arch joins the supporting wall

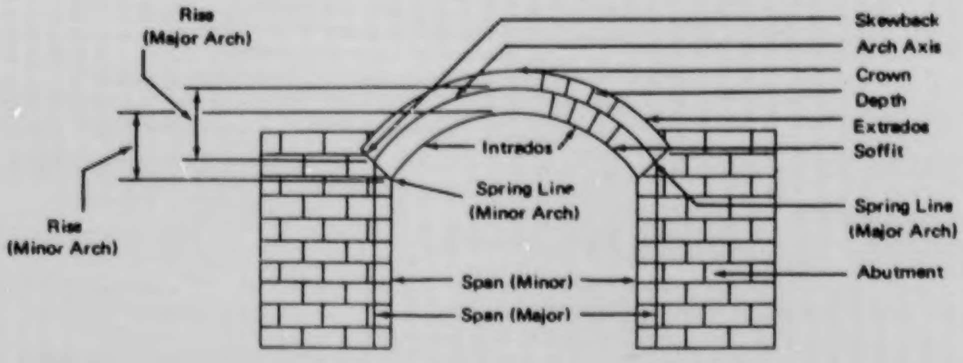

Rise
(Major Arch)
Rise
(Minor Arch)
Skewback
Arch Axis
Crown
Depth
Extrados
Soffit
Intrados
Spring Line
(Minor Arch)
Spring Line
(Major Arch)
Span (Minor)
Span (Major)
Abutment

Figure 1. Terminology of Arches

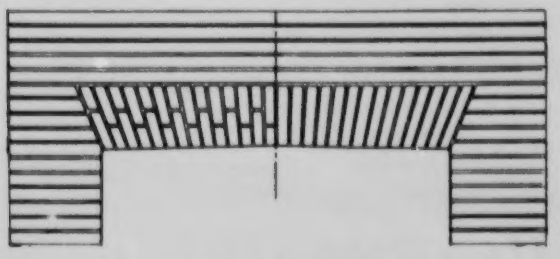


Figure 2. Jack Arch

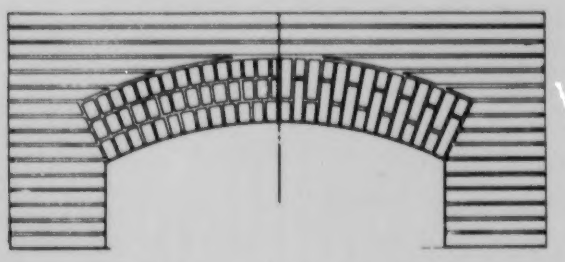


Figure 3. Segmental Arch

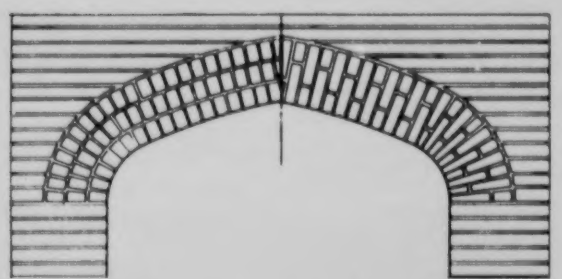


Figure 4. Tudor Arch

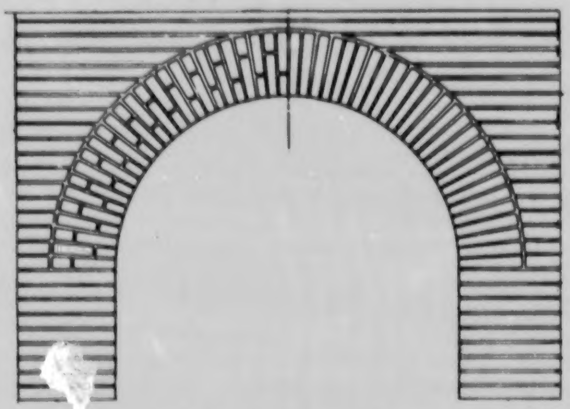


Figure 5. Roman Arch

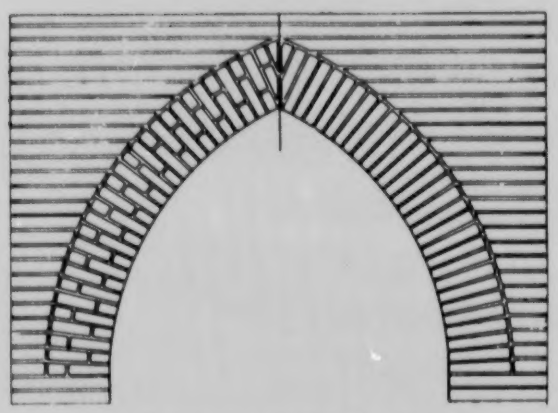


Figure 6. Gothic Arch

Soffit—the undersurface of the arch

Span—the horizontal dimension between abutments; for minor-arch calculations, the clear span of the opening is used; for a major parabolic arch, the span is the distance between the ends of the arch axis at the skewback

Spring line—in minor arches, where the skewback cuts the soffit; in major parabolic arches, the intersection of the arch axis with the skewback

Tudor arch—a pointed four-centered arch of medium rise-to-span ratio

Voussoir—one of the wedge-shaped masonry units that form an arch ring

Arch Forms

An arch is usually constructed to support the wall above an opening, such as a door or window. An arch also be used as ornamentation, however, and support little or no weight. It supports itself by the arrangement of blocks or bricks that distributes equal pressure on each block or brick. The arch supports weight because each brick in the arch acts as a wedge. When the opening is narrow, the arch can be made small so that little depth is required. For an opening of 3 feet or less, one or two rowlock rings of brick set on edge are sufficient. When greater distances are spanned, an arch is needed whose thickness corresponds to the width of the opening. Arches must be designed to carry different weights and types of loads.

Jack arch. The jack arch (fig. 2) has radial joints that are uniformly wide across the entire length. Either regular bricks are cut in wedge shapes with horizontal surfaces at the bottom and top of each brick, or special bricks are used. An inexpensive type of jack arch may be constructed in which the bricks are not cut into wedges, but are rubbed at the extrados and soffit only. This makes the horizontal joints between the ends of the bricks come at right angles to the radius upon which the bricks are laid. The radial joints will be wider at the top than at the bottom. Mortar joints make up the difference. In relation to other arches, a jack arch is weak and should be supported on steel lintels for all openings that are wider than 2 feet.

Segmental arch. The segmental arch (fig. 3) is very strong. The rise given to a segmental arch depends partly upon the load carried and partly upon the design of the building. Most masons make the rise one-eighth of the span. These arches may be constructed of alternate headers and stretchers where appearance is a factor. Unless special bricks are used or the bricks are gauged or rough axed, the mortar joints will be wider at the extrados than at the intrados.

Tudor arch. The Tudor arch (fig. 4) is a pointed four-centered arch of medium rise-to-span ratio. It is used over entrances to apartment houses and with other buildings that are designed in the Tudor style.

Roman arch. The Roman or semicircular arch (fig. 5) is a very strong arch, constructed of one or more courses of rowlocks or stretchers or a combination of both. Gaged or plain bricks may be used. However, if plain bricks are used, the width of the joints at extrados and intrados will differ.

Gothic arch. The Gothic or pointed arch (fig. 6) is used in church architecture and other large buildings where both strength and beauty are desired. When the crown must support the arch load, it is best to use the Gothic arch. The sides consist of arcs of circles whose centers are level with the spring line.

Exercise

1. What is an arch axis?
2. What are the bricks called that are in a wall adjacent to an arch and are cut to conform to the curvature of the extrados?
3. What is an extrados?
4. What is a keystone?
5. Define skewback.
6. Define the arch term soffit.
7. Describe a Tudor arch.
8. Give the name of the wedge-shaped masonry units that form an arch ring.
9. How does an arch support weight?
10. What arch has radial joints that are uniformly wide across the entire length?
11. Because a jack arch is weak, what are used as supports for openings wider than 2 feet?
12. Which arch is best if the arch load comes at the crown?

I-3

Arch Construction

***Objectives:** After completing this assignment, you will be able to—*

1. *give the basic elements concerning arch construction;*
2. *discuss the construction procedures of a jack arch; and*
3. *discuss the construction procedures of a segmental arch.*

Basic Construction

Arches must be constructed with the aid of temporary shoring or centering, and the centers are set with stays and then adjusted with wooden wedges. After the mortar in the arch has set, the wedges are removed and the center is released. The purpose of the centering is to carry the dead load of the arch, therefore the centering should not be removed until the masonry is capable of withstanding all expected loads. For regular brick arches, the centering should remain in place for ten days after the arch has been completed.

The arch must be laid out properly before construction begins. The correct number of courses should be figured before any work is done. The structural strength of an arch depends on the compressive and bond strengths of the mortar used and that all mortar joints must be filled completely. Most clay (brick) masonry arches are constructed so that the units at the crown are laid in soldier bond or rowlock header bond. Sometimes two or more rings of rowlock headers are recommended to help achieve full mortar joints and to provide a bond through the wall.

Because construction of different arches follows similar procedures and because space in this manual is limited, the construction of only two types of arches are detailed.

Construction of a Jack Arch

The jack arch may be constructed very quickly. Details are shown in fig. 1. The voussoirs are cut on the top and bottom only. The difference of the dimensions of the intrados and extrados is in the vertical joints, and the joints are usually about 3/4 inch on the top and about 1/4 inch or less on the bottom. To construct a jack arch, lay out the two piers using the number of bricks shown on the first course plan. Construct the piers to a height of 16 or 18 courses. Place an angle iron with a 4-inch bearing across the top, and place a board at the bottom of the piers to act as a radius-point holder. To determine the radius point, use the dimension of the span. From the spring point, fix a mark on the board and then reverse the operation. The intersection of these two marks is the radius mark.

Cut the skewbacks by drawing a line from the radius point to the spring point and setting the bevel square to this angle. Place three lines on the face of the arch. The first brick should be laid up with the bottom of the brick placed tightly against the skewback. Mark the bottom of the brick as shown in the illustration, and cut and relay the brick. Lay the top brick the same way by cutting the top of the brick to the top line. Continue to lay and cut the voussoris as before from both sides. The key course should be placed last.

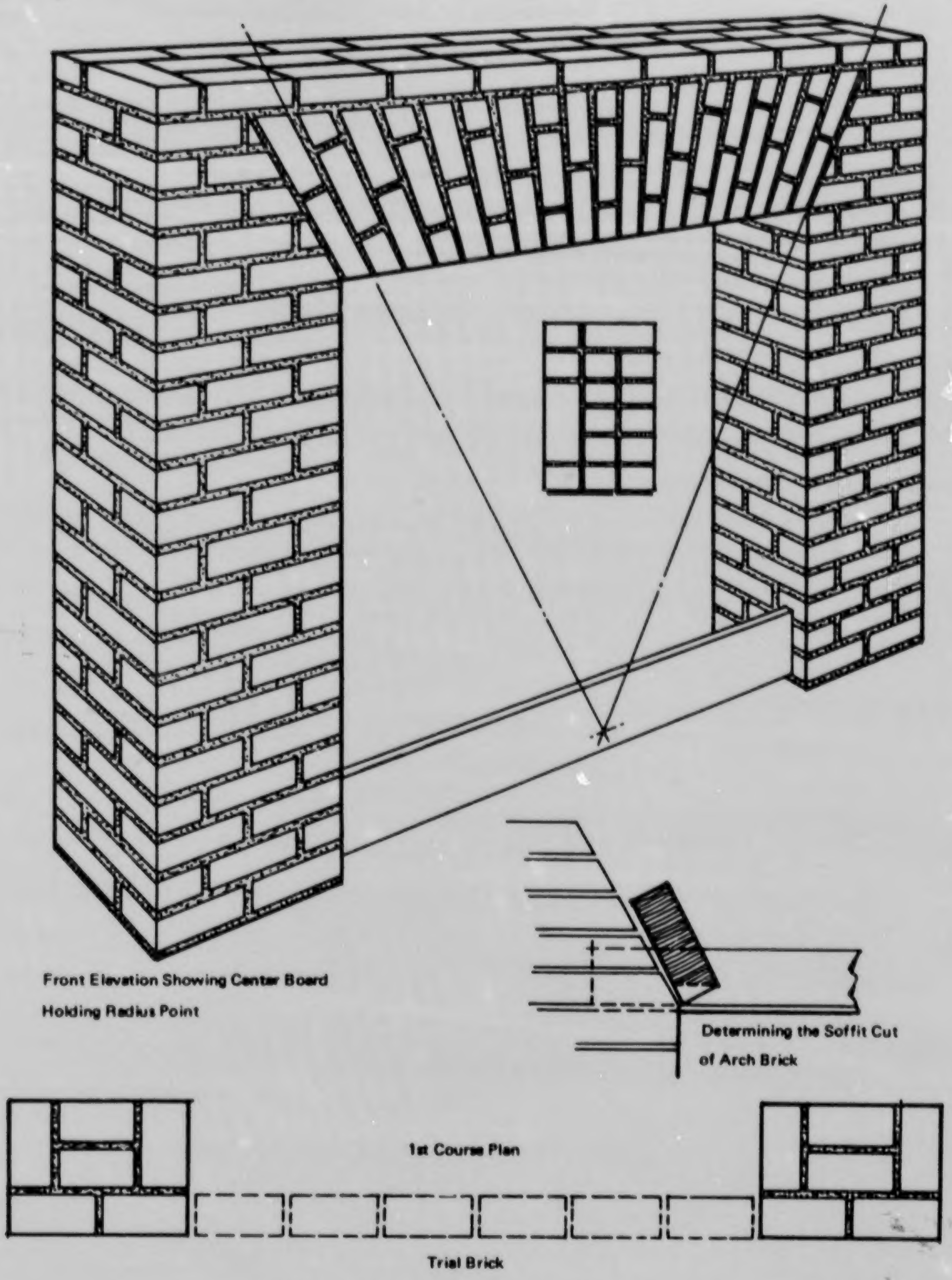

Front Elevation Showing Center Board
Holding Radius Point
Determining the Soffit Cut
of Arch Brick
1st Course Plan
Trial Brick

Figure 1. Construction of a Jack Arch

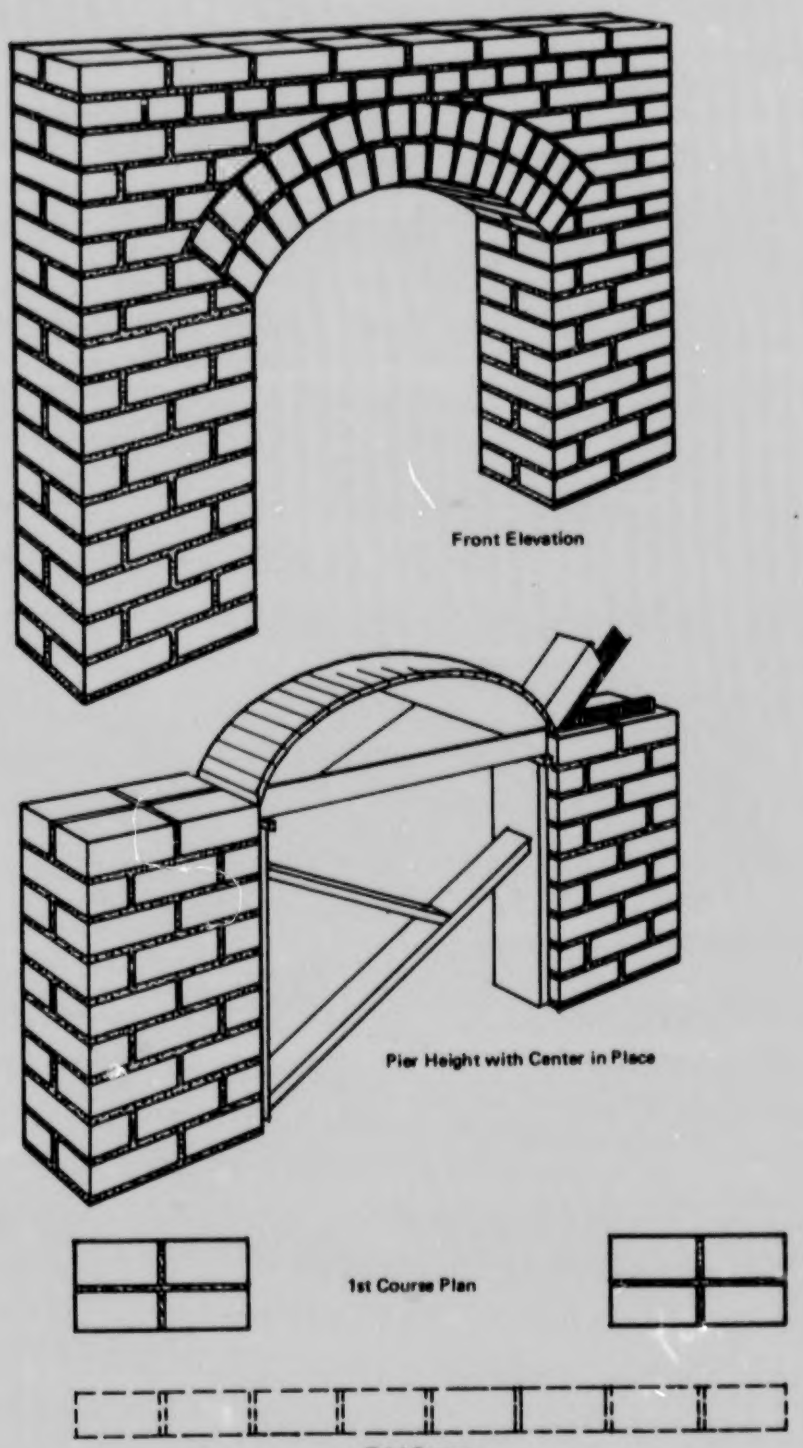

Front Elevation
Pier Height with Center in Place
1st Course Plan
Trial Course

Figure 2. Construction of a Two-Rowlock Segmental Arch

The arch may be backed up as desired with either angle irons or a relieving arch.

Construction of a Segmental Arch

Many arches are built with the aid of temporary centers. This method properly shapes the arch when no other form is specified. A simple two-rowlock arch (fig. 2) is usually used in a basement or in an interior wall.

Place the temporary wooden center on the floor and lay out the trial course so that the bond will be the same as that shown on the first course plan. Build up the two piers as abutments until they are 9 courses high. Straightedge, level, and plumb the front of the piers. Place two stays against the piers and brace them tightly. The top of the stays should be high enough so that the spring point of the center is about 1/2 inch below the top of the last course of brick.

Place the wooden center level on top of the stays and adjust it with wedges. The center should be level both horizontally and vertically at the bottom, and the spring point of the center should meet the top of the last course of brick. The rise of the center should be in course height at two or three courses.

Build the lead up the next three courses. The cut of the skewbacks should be measured with a bevel square. Place the bevel square on the last course of brick with a trial brick standing at right angles to the center. The blade of the square will fit the brick. This angle will be the proper one for the skewbacks used in this example. After the skewbacks are built, place a line on the twelfth course. The bricks should be spaced out to determine both the number of bricks and the thickness of joints required. The brick should be buttered (coated with mortar) with the face down. Also, be certain that the key brick is tight, or the arch may fail.

Increase the leads and run out the next rowlock. This ring will have one or more bricks because the radius has increased. Continue the leads and cut the creepers to the line using a rule. After the job has been completed, release the wedges. This will allow the center to loosen sufficiently so that the materials may be easily removed. The joints can then be finished on the soffit.

Exercise

1. What materials must be used to support the arch during construction?
2. What is the purpose of the centering?
3. What does the structural strength of an arch depend on?
4. How are the skewbacks in a jack arch cut?
5. When should the key course of a jack arch be placed?
6. What joints are finished after the center has been removed?
7. How long should the centering remain in place after an arch has been completed?
8. What are sometimes recommended to help achieve full mortar joints and to provide a bond through the wall?
9. Where is the difference of the dimensions of the intrados and extrados in a jack arch?
10. What is used to measure the cut of the skewbacks in a segmental arch?
11. What may happen if a key brick is not tight?
12. What allows the center to loosen sufficiently so that bracing materials may be removed?

J-1

Chimneys

Objectives: *After completing this assignment, you will be able to—*

1. *discuss the construction procedures to use for chimneys;*
2. *give the method used to make a smoke test; and*
3. *describe techniques used to maintain a chimney.*

Construction

Flue. The flue is the passage in the chimney through which air, gases, and smoke travel. The height, shape, smoothness, and tightness determine how effective the chimney is in producing the proper draft, thus removing smoke and gases. If the flue walls are sound, there is little danger of a fire occurring in a chimney. Most fires are caused by overheated or defective flues.

Chimney height. A chimney should extend at least 3 feet above flat roofs and at least 2 feet above a roof ridge or raised part of a roof within 10 feet of the chimney. A hood should be added if a chimney cannot be built high enough above the ridge to prevent trouble from wind deflection from the roof.

Chimney support. The chimney must rest on a solid foundation to prevent settling. Concrete footings should be used. They should extend at least 6 inches beyond the chimney on all sides and should be 8 inches thick for one-story houses and 12 inches thick for two-story houses with basements.

If there is no basement, pour the footings for an exterior chimney on solid ground below the frostline. In a house where the wall is solid masonry at least 12 inches thick, the chimney can be built into the wall and offset on the outside to give flue space. The offset should not extend more than 6 inches from the face of the wall.

Chimneys in frame buildings should be built from the ground up. If the walls are of solid masonry 12 inches thick and have proper footings, they can rest on the building foundation or basement walls.

Flue lining. Chimneys can be built without flue lining to reduce cost, but lined flues are much safer and more efficient. If the chimney is made of brick, a lined flue is definitely recommended.

Flue lining must withstand rapid changes in temperature and the action of flue gases. For this reason, vitrified fire clay at least five-eighths of an inch thick should be used. Both rectangular and round-shaped linings are available, but a brick chimney is easier to construct with a rectangular lining.

Each length of lining is cemented into place with mortar. Then the joint is struck smooth on the inside and the brick or stone placed around it. In masonry chimneys with walls less than 8 inches thick, there should be space between the lining and the chimney walls. Do not fill this space with mortar.

Flues should be as nearly vertical as possible. If a change in direction is necessary, never exceed 45 degrees. When laying lining and brick, pull a tight-fitting bag of straw or other material up the flue beneath the mortaring operation to catch any loose mortar that may fall.

Walls. Chimney walls not more than 30 feet high, with lined flues, should be at least 4 inches thick if made of brick or reinforced concrete and at least 12 inches thick if made of stone.

A minimum thickness of 8 inches is needed for the outside wall of a chimney if it is exposed to the weather. Some chimneys contain more than one flue. Building codes normally require a separate flue for each fireplace, furnace, or boiler. If a chimney contains three or more lined flues, each group of two flues must be separated from the other single flue or group of two flues by brick divisions or wythes at least 3 3/4 inches thick.

Insulation. Never allow any wood to be in contact with the chimney. Leave a 2-inch space between the chimney walls and all wooden beams or joists. Fill the space between wall and floor framing with porous, non-metallic, incombustible material. Do not use brickwork, mortar, or concrete. Flooring and subflooring can be laid within three-fourths inch of the masonry.

Wood studding, furring, or lathing should be set back at least 2 inches from chimney walls. A coat of cement plaster should be applied to chimney walls that will be encased by wood partition or other combustible construction.

Roof connection. Provide a 2-inch clearance between the wood framing and the masonry at the roof. This gives fire protection and also permits expansion caused by temperature changes, settlement, or movement during heavy winds.

Chimneys must be flashed and counterflashed to make the junction with the roof watertight, as shown in figure 1. Corrosion-resistant metal such as copper, zinc, or lead should be used for flashing.

Top construction. The flue lining extends at least 4 inches above the cap or top course of brick and is surrounded by at least 2 inches of cement mortar. The mortar is finished with a straight or concave slope to direct air currents upward at the top of the flue and to drain water from the top of the chimney.

Hoods are used to keep rain out of chimneys and to prevent downdraft due to nearby buildings, trees, or other objects. Some hoods contain screens to keep sparks from escaping and also to keep out birds or small insects.

Smoke Test

A flue must be tested before it is used. Build a paper, wood, or straw fire at the base of the flue. When the smoke rises in a column, completely block the outlet at the top of the chimney with a wet blanket. Smoke that escapes through the masonry will show the location of any leaks. This test will also locate leaks into adjoining flues, the wall, or between the lining and the wall. Correct defects immediately.

Chimney Maintenance

Chimneys should be inspected each year before they are used. See that there are no loose bricks, cracked flue linings, or excessive soot accumulation. Mortar joints should also be checked. Make all necessary repairs. Bricklayers do not routinely make these checks, but the new owners should be informed of this necessity.

Chimney cleaning is usually necessary every two years. This can be done by the owner, by pulling a bag of straw or other materials through the chimney several times, then vacuuming the lower part of the chimney. Commercial chimney cleaners usually do a better job and at reasonable prices. Inform the new owner that burning pine has a tendency to cause rapid soot buildup.

Exercise

1. What is the chimney passage called through which air, gases, and smoke travel?
2. What are most chimney fires caused by?
3. How far should a chimney extend above a roof ridge or raised part of a roof within 10 feet of the chimney?
4. What should be used as a footing for a chimney?
5. What should be used for a flue lining?
6. When should there be a space between the lining and the chimney walls?
7. Building codes usually require a separate flue for what structures?

8. How much space should be left between the chimney walls and all wooden beams or joints?

9. What is used to make the chimney junction with the roof watertight?

10. How far above the cap or top course of brick should the flue lining extend?

11. What type of test is used to see if there are leaks in the chimney?

12. How often should chimneys be inspected?

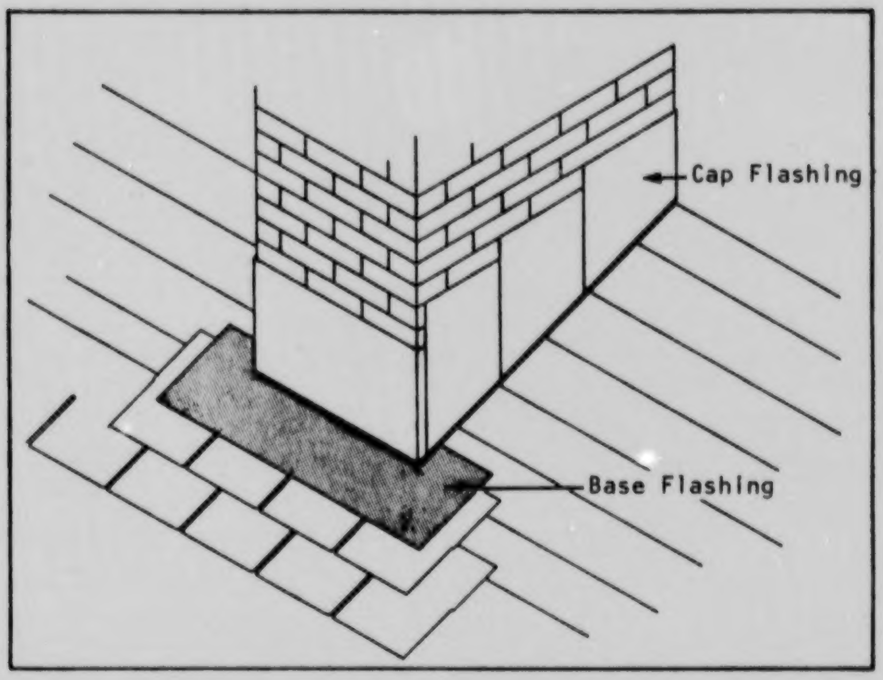


Figure 1. Chimney Flashing

J-2

Fireplaces

Objectives: *After completing this assignment, you will be able to—*

1. *describe the types of fireplaces in use today;*
2. *identify and discuss the parts of a fireplace; and*
3. *discuss the basic procedures used to construct a fireplace.*

Types of Fireplaces

A number of different types of fireplaces are now being used in residential structures (fig. 1). Although the styles may differ, the construction elements remain basically the same.

Single-face fireplace. The single-face fireplace is the most popular style; it has been used for hundreds of years. When built properly, with correct dimensions used, and quality workmanship practiced, it will perform as expected without danger of smoking.

Multiple-face fireplace. Although most people consider the multiple-face fireplace to be a modern design, it has been used for many years. The two-face adjacent, two-face opposite, and three-face fireplace are in use today. More problems are usually associated with multiple-face fireplaces because of cross drafts. Sometimes such devices as oversize flues, controlled face openings, or glass fire screens are used to eliminate smoke problems.

Sizes of Fireplaces

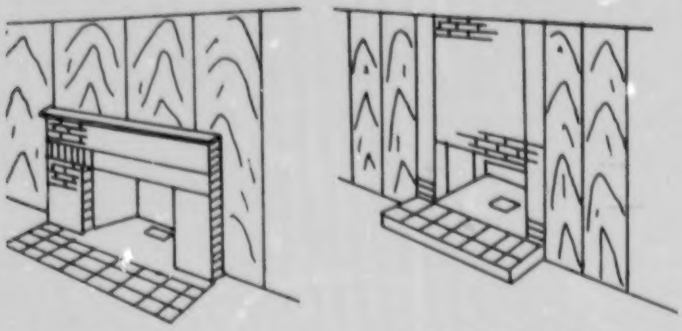
The size of a fireplace varies from house to house, depending upon the size of the room in which the fireplace in to be housed. A large fireplace in a small room generates too much heat and appears out of proportion in the room. For example, a room containing 300 square feet of floor space is well served by a fireplace with an opening 30 to 36 inches wide. The height of the fireplace opening must also be kept in proportion to the width opening. Most height openings are 32 inches or less. Fireplace opening sizes are shown in table 1.

Parts of the Fireplace

The designs of fireplaces vary considerably; however, the parts are similar (fig. 2). One of the most important parts is the combustion chamber. The shape and depth of this chamber influence draft and heat radiation in the room. The slope of the back pushes the flame forward and allows the gases to escape through the throat. The combustion chamber should be lined with firebrick and thin-jointed fireclay mortar. The walls of the fireplace combustion chamber should be between 6 and 8 inches thick to give ample support to the chimney above.

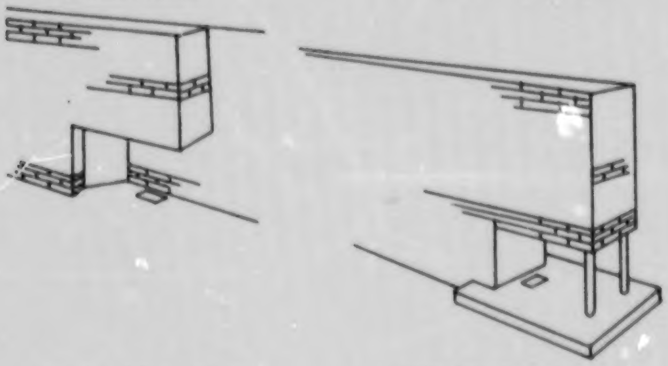
Because of its critical effect on draft conditions, the throat of the fireplace must be carefully designed. The opening of the throat should be at least 6 inches wide and located about 8 inches above the highest point of the fireplace opening. The back should slope and extend to the same height to form the support for the back of the damper.

The metal damper is housed in the throat, and it should extend the full width of the fireplace opening. It operates more efficiently when the valve plate opens upward toward the back. This plate forms a barrier to the downdraft of smoke and deflects it into the ascending column of smoke. The damper should be kept closed when the fireplace is not in use because an open damper allows not only heat or cool air to escape



Single-Face Fireplace

Two-Face Opposite Fireplace



Two-Face Adjacent Fireplace

Three-Face Fireplace

Figure 1. Basic Types of Fireplaces

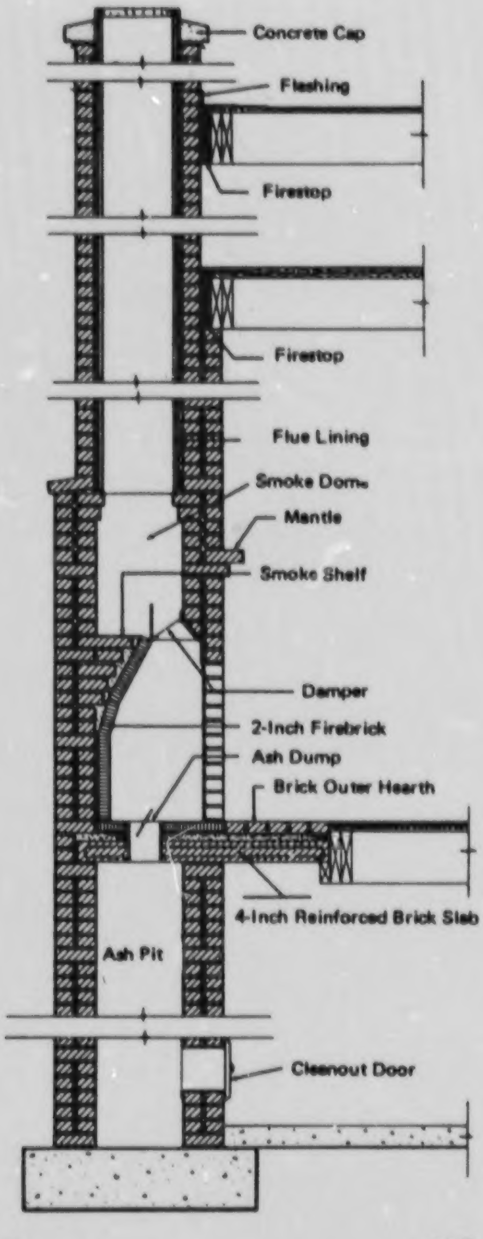

Concrete Cap
Flashing
Firestop
Firestop
Flue Lining
Smoke Dome
Mantle
Smoke Shelf
Damper
2-Inch Firebrick
Ash Dump
Brick Outer Hearth
4-Inch Reinforced Brick Slab
Ash Pit
Cleanout Door

Figure 2. Cross Section of a Fireplace

from the chimney, but also insects and water to come into the fireplace.

The smoke shelf is directly below the bottom of the flue and extends the full width of the throat. It must be constructed horizontally, with no slope, since its primary purpose is to stop the downdraft of air or smoke.

The opening above the smoke shelf is the smoke chamber. It has a straight back wall and the side walls slope uniformly to the center. These walls meet the bottom of the flue lining, and the front wall above the throat is sloped to the flue lining. Sometimes metal lining plates are used for the smoke chamber because they give proper form to the chamber and have smooth surfaces.

Relatively high air or smoke speeds are desirable through the throat and flue of the fireplace, and both the area of the flue and the height of the chimney affect these speeds. There should be independent flues for fireplaces, and each flue should be free from other openings or connections.

To obtain a positive and uniform draft over the full width of the fireplace, the first section of the flue lining must start at the center line of the fireplace opening. The flue lining must be supported on at least three sides by a ledge of projecting brick, and finished flush with the inside of the lining.

The easiest way to construct a hearth is by using a reinforced brick masonry cantilevered slab. The slab covers the entire area of the chimney base for the width of the hearth. The brick should be set to form the proper openings for the ash chute and basement flue, and the joints should be closed with mortar to hold the grout fill. The flue lining from below should be placed to extend above the slab, and the brick and grout should be placed around it.

The jambs of a fireplace should be wide enough to provide stability and to present a good appearance. For a fireplace opening 3 feet wide or less, the jambs can be as much as 12 inches wide if a wood mantel will be used, or 16 inches wide if the mantel will be exposed masonry. For wider fireplace openings, or if the fireplace is in a large room, the jambs should be proportionately wider. Fireplace jambs are often faced with ornamental brick or tile.

No woodwork should be placed within 6 inches of the fireplace opening. Woodwork above and projecting more than 1 1/2 inches from the opening should be placed at least 12 inches from the top of the fireplace opening.

A lintel must be installed across the top of the fireplace opening to support the masonry. For a fireplace opening 4 feet wide or less, 1/2- by 3-inch flat steel bars, 3 1/2-by 3 1/2- by 1/4-inch angle irons, or specially designed damper frames may be used. Wider openings require heavier lintels.

If a masonry arch is used over the opening, the fireplace jambs must be heavy enough to resist the weight of the arch.

Fireplace Construction

A fireplace and chimney assembly may be built by two different methods. Some masons construct the fireplace and chimney in one operation while the work is progressing. When using this method, the facing is done later, but ties are built in so that the face may be properly bonded into place.

The other method consists of forming a rough opening for a fireplace that will be constructed at a later time. The end and back walls are built to a thickness of 8 inches with a steel lintel set below the shelf level to carry the front wall above. The back and sides of the smoke chamber are then formed, and the flue is built in. When building in the fireplace, the work must be finished tightly to the underside of the chimney that has already been constructed.

Exercise

1. What is the most popular style of fireplace?
2. Why are there more problems associated with the use of multiple-faced fireplaces?
3. What should be the width of a fireplace that serves a room of 300 square feet?
4. What is the usual height of a fireplace opening?
5. What should be used to line a combustion chamber?
6. How wide should the opening of the throat of a fireplace be?
7. What is the purpose of a damper in a fireplace?
8. Where is the smoke shelf located?

9. Why are the metal lining plates used in the smoke chamber?
10. What affects wind and smoke speeds in the flue?
11. How are fireplace jambs often faced?
12. Why must a lintel be installed across the top of the fireplace opening?
13. When the fireplace and chimney are built in one operation, what is omitted until later?

Table 1
Dimensions for Fireplaces

Opening			
Width	*Height*	*Depth*	*Outside Dimensions of Flue*
24	24	16-18	8½ x 8½
28	24	16-18	8½ x 8½
24	28	16-18	8½ x 8½
30	28	16-18	8½ x 13
36	28	16-18	8½ x 13
42	28	16-18	8½ x 18
36	32	18-20	8½ x 18
42	32	18-20	13 x 13½
48	32	18-20	13 x 13
42	36	18-20	13 x 13
48	36	18-20	13 x 13
54	36	18-20	13 x 13
60	36	18-20	13 x 18
42	40	20-22	13 x 13
48	40	20-22	13 x 18
54	40	20-22	13 x 18
60	40	20-22	18 x 18
66	40	20-22	18 x 18
72	40	22-28	18 x 18

K-1

Fundamentals of Masonry Floors

Objectives: *After completing this assignment, you will be able to—*

1. *describe the types of joints used on interior and exterior floors and pavements;*
2. *discuss the use of reinforced brick surfaces; and*
3. *explain how to finish and maintain brick surfaces.*

Interior Floors

Joints of interior brick floors may be made with or without mortar. As a general rule, these floors are placed over concrete slabs, but they may also be used successfully over tamped soil. Brick floors are not usually reinforced since they are used primarily for appearance and economy. The construction elements are the base, the cushion, the wearing surface of brick or tile, and the joints. Construction procedures vary according to the type of joint used.

Mortared joints. Interior floors are often placed in a bed of mortar with mortar used for joints. The base is usually a concrete slab and the cushion is a bed of mortar about 1/2 to 1 inch thick. When the brick is laid, both the cushion and the joints are created. The brick is pushed into the mortar, and the mortar is pushed up into the joints between each unit. Excess surface mortar should be brushed or wiped away with burlap rags as soon as it begins to stiffen. This method of laying floors either simplifies cleaning operations or makes them unnecessary.

Mortarless joints. Mortarless brick floors have become increasingly popular during the last few years because they may be laid faster and are more economical than floors with mortared joints. The base must be prepared carefully for this type of floor because there are no filled joints to help reinforce the brick. The base may be a concrete slab or well-tamped soil. The cushion consists of sand that has been compacted by tamping or by "floating" with water. The bricks must be placed as closely together as possible in a herringbone or running bond for best resistance to movement. After the floor has been laid, fine sand should be swept over the surface of the bricks so that joint irregularities will be filled.

Exterior Surfaces

Using brick for outside flooring is similar to using brick for interior flooring except that drainage, freezing, and thawing must be taken into consideration. The elements for outside paving are the base, the cushion, the wearing surface, and the joints.

Moisture and drainage. Outside brick paving is usually subject to excessive moisture. There may be problems associated with efflorescence, stains, freeze and thaw disintegration, and the growth of fungi or molds. Drainage should be a prime consideration. Walks must be sloped to one side or both sides by constructing a crown. Slope patios away from the building or walls unless gutters are provided to remove the water from that area. Usually, a 1/8- to 1/4-inch slope per foot is enough to remove the water.

When large areas are to be bricked, below-surface drainage is sometimes necessary. This may be done by sloping the base and setting brick directly on pea gravel. However, if the soil base is sandy or contains a large amount of silt, the water will be removed through seepage. In this case, the gravel is unnecessary. A layer of sand is normally used directly under the brick to allow for leveling and placement. Do not place sand over gravel because it has a tendency to sift down into the gravel and cause both uneven settling and water blockage.

Edging. Exterior brick pavings have a tendency to spread or shift around the edges during normal conditions. This movement is contained with edging. The edging usually consists of a soldier course of bricks set in either concrete or mortar. Place the edging first, then add the wearing surface inside the perimeter. Provide drainage openings at the lower part of the edgings in order to eliminate excess water.

Reinforced Brick Surfaces

Reinforcement is used to span an open space or to cover an area that has been filled, but may settle at a later date. When using reinforced bricks, it usually is not necessary to pour a slab base. How the bricks are placed depends on how much weight will be placed on them. Bricks may be laid flat or on edge, and sometimes it is necessary to place one layer of bricks on edge and cover them with a layer that is set flat. Always know how much compressive strength the brick you are using should withstand.

Finishing and Maintaining Brick Surfaces

When a smooth finish is desired, a terrazzo grinder may be used to produce a smooth, plane surface. You will achieve the best results on hard-burned dense brick. It has sufficient resistance to abrasion and allows grinding action without crumbling. Results are usually unsatisfactory when working on highly porous brick because grinding may expose air bubbles that lie below the surface of the brick. Porous brick is very hard to seal or finish. Allow about one week for the cushion and joints to cure before grinding is started. If grinding is begun before the material has cured, it may loosen.

The floor should be sealed before waxing. Masonry silicones, either solvent-based or water-based, are often used for sealers. When the sealer has dried, a floor wax may be applied to the surface. Most wax manufacturers produce a special wax for brick floors. Varnishes or shellac should not be used as a finish. They do not wear well and soon become worn and spotty.

A natural or ground surface may be waxed or left in its natural state. Virtrified materials do not absorb liquids or discolor as easily as bricks with lesser densities. A waxed floor will require maintenance, although it may withstand stains. Exterior surfaces should not be sealed or waxed because they have a tendency to trap water. This may result in freezing during the winter months.

Exercise

1. What two types of joints are used for brick floors?
2. What are the four construction elements for interior floors?
3. How thick should the mortar cushion for a brick floor be?
4. What types of bonds are recommended for mortarless joints in paving?
5. What should be taken into consideration when constructing exterior paving?
6. How much slope should be allowed to eliminate water from a floor or walk?
7. How may below-surface drainage be provided for large paved areas?
8. Why should edging be placed around exterior paving?
9. What is used to give a smooth finish to laid brick?
10. What happens when highly porous bricks are ground?
11. What materials are often used for sealing brick floors?

K-2

Construction of Masonry Floors

***Objectives:** After completing this assignment, you will be able to—*

1. *discuss the steps to follow when constructing basket-weave paving;*
2. *give the procedures for constructing a herringbone pattern;*
3. *outline the procedures for constructing diagonal basket-weave paving; and*
4. *give the steps to use when laying reinforced brick pavement.*

Basket-Weave Paving

The basket-weave pattern is often used for paving short walks, porches, floors, landings, and terraces. Because walks and pavements must be capable of eliminating water, they should be laid slightly out of level. When paving with this pattern, mix the sand used as a base while it is damp, using one part of cement to three parts of sand. Fill face joints with a stronger mortar made of one part of cement to two parts of sand. This mortar should be mixed fairly soft so that it will pour into the joints. When it has partially dried, wipe the surplus mortar off and wash the masonry.

When laying a basket-weave pattern job (fig. 1), fill the form with sand to the height shown in the cross section of the illustration. Lay brick number 1 level with the form and brick number 2 projecting 1/4 inch above the form. Brick number 3 should be 1/2 inch above the form, and brick number 4 should project 3/4 inch above. Always check these levels before proceeding with the job. Lay a temporary straightedge from brick number 1 to brick number 2, and then lay the remainder of the course. Repeat this same operation between bricks number 3 and 4. Stretch lines to insure that the cross joints are straight. Each block or square may be kept uniform by using the straightedge for each course and laying the cross joints to the lines. After the job has been laid up, use a straightedge 2-inch by 4-inch piece of material to hammer down and level the four points. There should be no pockets or low spots where water might stand. Fill the vertical joints with sand to the top of the brick and brush off the excess sand.

Diagonal Basket-Weave Paving

When laying out the diagonal basket-weave pattern (fig. 2), take care to center the job so that no matter what width is used, cuts of the same size will show on each side. Because this job is laid in the same form as other paving jobs and is square, the cuts should be of the same shape and size at opposite ends of the form.

After the sand base has been prepared, make the cuts shown in the illustration. Use a wooden triangle and a straightedge to lay the brick. Spot temporary bricks at the other

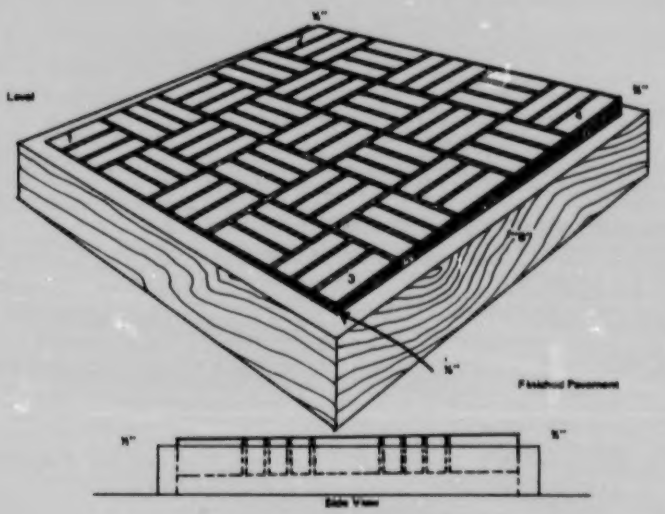

Level
Finished Pavement
Side View

Figure 1. Basket-Weave Paving

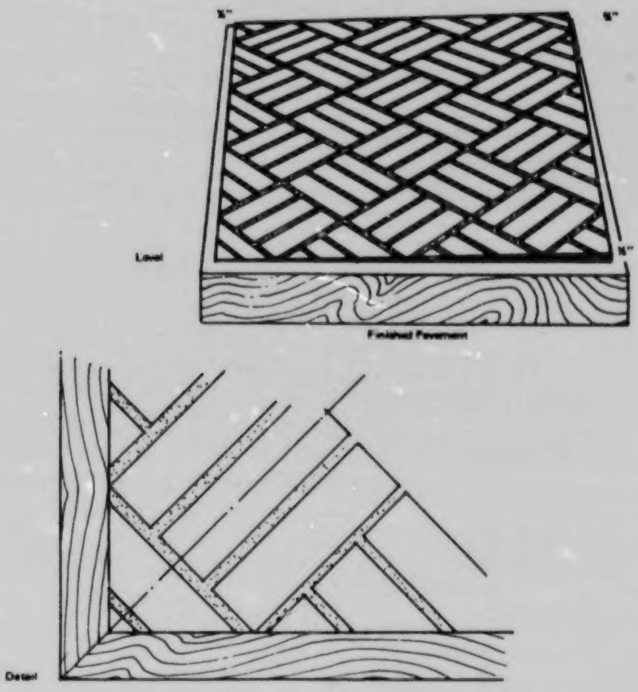

Level
Finished Pavement
Detail

Figure 2. Diagonal Basket-Weave Paving

three corners, and start laying down the cut bricks. They must be fitted to the form and triangle as in the lower left-hand corner of the illustration. Draw lines at right angles to the straightedge. Use the lines and straightedge to lay down each block, then square it by the triangle fitted to the straightedge. The straightedge should be moved every 8 1/2 inches, parallel to the last position. Repeat these operations using an extra straightedge to line up the brick to the four height positions shown at the corners of the illustration. Finish the job by filling the joints with sand and brushing off the excess.

Herringbone-Pattern Paving

The herringbone pattern (fig. 3) is useful because it eliminates any straight-line joints. It is sometimes used at street intersections. The sand base, or bed for the herringbone pattern is prepared the same way it is for other paving jobs discussed in this lesson. The various level points are established, as shown at the four corners of the illustration. By scaling, make several triangular end cuts to the measurements shown in the 3-inch detail of the illustration. Place a straightedge on the form as indicated.

Lay the bricks cut to the shape of triangles so that the centers of each fourth one will have the same dimension as shown on the plan. Lay down the full brick allowing 1/2-inch joints so that the corners of each brick will touch the straightedge. Check the angles by using the wood triangle against the straightedge and brick. Finish laying the area up to the straightedge, then move it back six more inches. The full brick can then be laid down by using the wooden triangle. The cuts on the side should be the same size, but reversed. Place the centers of the small triangular cuts, and finish the job by filling the joints flush with sand and pressing down to within 1/2 inch of the surface. Mortar should be one part cement and one part lime to five parts finely screened sand. Mix the mortar until it is a stiff batter. Using a jointing tool, fill the joints flush with the top of the brick. Finish the joints with a flat jointer.

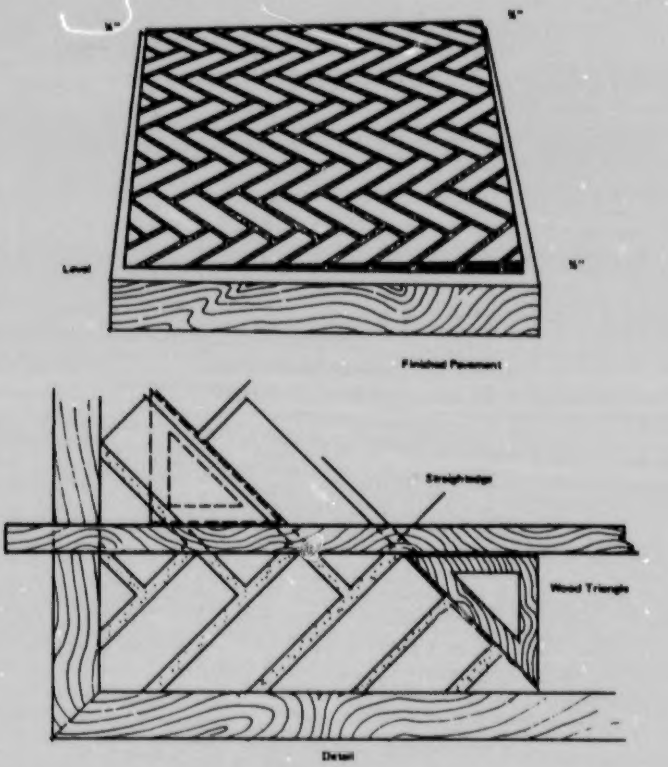
Reinforced Brick Pavement

The base and cushion, or leveling bed, should be prepared the same way for reinforced brick pavement as it is for unreinforced pavement. When the slab spans open spaces, place the brick directly on forms and use a pipe, thin board, or other suitable material of the proper thickness to space and position the brick. After a row of bricks has been placed, remove the spacer, slush in a small amount of mortar, and tamp the mortar to a uniform height, depending on the required location of reinforcing steel. The mortar keeps the bricks in place, seals the bottom of the joints, and serves as a bed for the reinforcing steel. After all materials are in place, grout the joints. As always, be sure that all joints are completely filled.

When slabs are 2 brick courses thick, the first course is constructed as described earlier and then a bed of mortar is spread over the course and smoothed to the proper thickness. Tempered reinforcement or conduit can be placed in the joint. The top course is then placed on the mortar bed, reinforced if necessary, and the joints are grouted.

Exercise

1. What should be used to fill face joints in basket-weave paving?
2. After mortar has been poured into the paving joints, how should the surplus mortar be eliminated?
3. How should each block or square be kept uniform in basket-weave paving?
4. Why should diagonal basket-weave paving be carefully centered?
5. What is the advantage of using the herringbone pattern when paving?
6. How are the base and leveling bed prepared for reinforced brick pavement?
7. Why should there be no pockets or low spots in a brick floor or pavement?
8. What instruments are used to lay bricks when constructing diagonal basket-weave paving?
9. What is the finishing step when constructing diagonal basket-weave paving?
10. What does mortar do when used in reinforced brick pavement?



Level
Finished Pavement
Straightedge
Wood Triangle
Detail

Figure 3. Herringbone-Pattern Paving

L-1

Cleaning New Masonry

Objectives: *After completing this assignment, you will be able to—*

1. *give the procedures for cleaning various types and colors of brick;*
2. *describe the different stains that may appear on masonry materials; and*
3. *discuss sandblasting and how it affects masonry materials.*

You may use the correct materials in building a structure, display outstanding workmanship, and create a beautiful design, but if you clean the units improperly after you have finished the job you may ruin the whole structure. Improper cleaning usually results from incorrect cleaning techniques or using the wrong type of cleaner.

Types of Stains

Internal stains. A person usually thinks of stains and blemishes appearing on structures as being introduced by an external force. The bricklayer has the added problem of combating efflorescence and stains that come from within the masonry units or the mortar through water and water evaporation.

Efflorescence is a white powdery substance sometimes seen on masonry structures. It is composed of one or more water-soluble salts that have been brought by water to the surface of the material. When the water evaporates, the salts are left on the surface.

Manganese stain normally occurs at the mortar joint between manganese grey or brown brick; it may also be deposited on the brick. It is usually a brown oily stain that originates from the manganese used to color the brick. Rain water acidified by carbon dioxide or sulfur in the air causes the manganese to dissolve. When the solution reaches the mortar joints, it is neutralized by the cement or lime in the mortar, and the salts are left there.

Green stains are usually caused by salts from vanadium. These salts may be colorless or colored. Colorless salts crystallize in alkaline and neutral solutions. They are easily soluble in water, and react very quickly. Colored salts are obtained from acid solutions. They are only slightly soluble, and are slow to change.

External stains. Masonry is subject to external stains from spills or plant growth. Some common kitchen cleaners may remove these stains.

Commercial emulsifying agents may remove most oils and tar stains, but heavy stains often require kerosene to remove the tar, and water to remove the kerosene. To remove oil stains from a small area, use benzene, naptha, or trichlorethylene.

If fresh paint has been spilled or splattered on the masonry, use either a commercial paint remover or a solution of trisodium phosphate in water. The trisodium phosphate mixture is usually 2 pounds of trisodium phosphate to 1 gallon of water. After applying the cleaner, allow it to stand, and then remove the paint with a scraper and wire brush.

To remove copper or bronze stains, mix 1 part ammonium chloride and 4 parts powdered talc while still dry. Add ammonia water and stir until it makes a thick paste. Put the paste on the stain and allow it to dry, then scrape it off with a wooden paddle, especially if the masonry is glazed tile. Several applications may be needed.

When welding materials have splattered on masonry, scrape off as much of the metal as possible, then apply a mixture of oxalic acid-ammonium bifluoride. If the stain remains after the mixture has dried and been scraped off, use sandpaper and apply a second mixture of paste.

Cleaning with Acid Compounds

Dry powder compounds. Because dry powder compounds require only the addition of water, they are quite useful at the construction site. They do not spill as easily as liquid, are not as dangerous to handle, and cost less to ship. Although a powder compound will burn the skin, it is much less dangerous than hydrochloric acid. The greatest disadvantage of using dry powder compounds is their chemical composition. The chief ingredient is sulfamic acid, which forms weak sulfuric acid in water. When this solution is applied to a masonry unit, the possibility of efflorescence increases. Also, because of the relatively low acidity, mortar stains are removed more slowly.

Inorganic acid compounds. Some liquid cleaning compounds are composed not only of hydrochloric acid, but also of other wetting agents. While these additional components improve the cleaning action, they can also slow the deterioration of the mortar joints. This means that they are safer to handle and less likely to subject the mortar joints to acid burn. These compounds have about the same effect in removing mortar as the conventional hydrochloric acid solutions of the same acid strength. Some of the inorganic acid compounds have been modified by the addition of oxidizing and chelating agents. These agents have been helpful in removing metallic ions such as those found in vanadium.

Organic acid compounds. The relatively new organic acid compounds are a blend of organic acids. They are made for specific cleaning problems. Some effectively remove mortar, but not all stains. Others remove stains, but lack the ability to remove mortar.

Cleaning Light Brick

Take care when cleaning light brick because it is more susceptible to acid burn and staining than dark brick. A reaction between the acid and metal tools or the iron impurities in the acid may produce yellow or brown stains on light-colored brick. If the cleaning process is not done right, the masonry may be streaked or the color dulled.

Two procedures are used for cleaning light brick, one without acid, and one with. Wait until the mortar has thoroughly set and cured before starting either process. Remove large particles of dry mortar from the masonry with a wooden paddle and scraper. Then remove loose particles with a chisel or wire brush. Soak the wall with clean water and flush all loose mortar and dirt from the surface. When cleaning without acid, use a solution of 1/2 cup of trisodium phosphate and 1/2 cup of household detergent dissolved in 1 gallon of clean water, and scrub the masonry with a stiff fiber brush. Finish the cleaning procedure by rinsing away all dirt, mortar crumbs, and cleaning solution from the masonry.

If the first procedure does not succeed in properly cleaning the masonry, then a second procedure with acid must be used. Acid should generally not be used for cleaning light-colored brick. When it is necessary, however, use only the highest grade, or chemically pure, hydrochloric acid—no more than 1 part acid to 15 parts clean water. Flush all loose mortar and dirt from the surface, then soak the area to be cleaned with acid and clean water. This will keep the acid and dissolved mortar from being absorbed into the masonry. The acid should be a clean, stain-free commercial grade of hydrochloric acid. Mix the 1 part acid to 15 parts clean water in a nonmetallic container. When mixing, always pour acid into water. If water is poured into the acid, an explosion is likely to occur. Place no metal in the solution. Apply the solution to the masonry and scrub it with a long-handled fiber brush. Keep all brickwork below the cleaning area free of the solution, and continue flushing with water.

Scrub the brick, not the mortar joints. Keep all metal tools away from the acid solution because rusting will begin when the tool comes into contact with the acid. Clean only a small area at a time, especially during hot weather, because the heat or warm wind will dry the area that has been flushed with water. Rinse the entire area with clean water after the scrubbing operation. The acid solution usually loses its strength after 5 or 10 minutes, and if the masonry is still dirty after the scrubbing operation, another application of solution may be used. Do not allow the acid solution to splash in the eyes or come into contact with the skin.

Cleaning Dark Brick

Dark brick—red, brown, or black—usually shows a light grey mortar scum of dissolved mortar and dirt. Sometimes brown and yellow stains are visible. The first procedure discussed for cleaning light-colored brick may be used on dark brick also. Acid is also used to clean dark brick, but dark brick requires a solution of 1 part acid to 9 parts water.

Cleaning Textured Brick

Textured brick will readily show stains. Dirt, mortar, and acid stains can still dull the natural color and beauty of the masonry. Mortar stains and smears are usually removed easily from smooth-textured brick. Presoaking and rinsing are easier because there is less surface area exposed, but the smooth surface will reveal poor rinsing or smears that have not been removed. Rough-textured brick allows mortar to be trapped in the surface, and cleaning and rinsing must penetrate these recesses. Use pressurized water to rinse dirt, dissolved mortar, and acid that is below the surface of the material.

Cleaning Tile and Glazed Brick

Tile and glazed brick should be wiped with a soft cloth as soon as it has been laid, and normally an additional cleaning with a soft sponge or brush and water will clean the material. If this does not do the job, the first procedure given for cleaning light-colored brick may be followed. Do not use metal cleaning tools, brushes, or abrasive powders. The second procedure, using acid, may be needed. If so, use no metal tools. Mix the acid solution to be no more than 1 part acid to 25 parts of clean water. Never use acid for cleaning on salt-glazed or metallic-glazed masonry units.

Sandblasting

Sandblasting is a cleaning procedure in which sand particles, propelled by high air pressure, are directed toward an object. Although sandblasting has been used for many years to clean older buildings, new techniques have recently been developed for use on new structures. While the cost varies from one area to another, the cost of most sandblasting is comparable to acid cleaning. Sandblasting eliminates the dangers of mortar smear, acid burn, efflorescence, and chemical reactions between masonry and liquid cleaners. The person sandblasting should take precautions to see that the eyes are protected by goggles or a face shield to avoid injury. Sandblasting equipment operators should wear respirators to avoid breathing the dust-laden air around the operation. An air pressure ranging from 60 to 120 pounds is normally used. The type of nozzle varies according to the type of masonry being cleaned, but the quarter-inch nozzle is most often used. The operator should not direct the blast at the mortar joints because it will etch into the softer material. Round sand particles are the best to use for sand blasting.

Exercise

1. Define efflorescence.
2. What two types of vanadium salts may be found on masonry structures?
3. What causes improper cleaning of masonry?
4. What is added to dry powder compounds before cleaning begins?
5. List three advantages of dry powder compounds.
6. What is the primary disadvantage of dry powder compounds?

7. What type of brick is more susceptible to acid burn and stains?
8. What tools are used to remove large particles of dry mortar from masonry?
9. What type of acid should be used for cleaning most masonry units?
10. What acid dilution is used for cleaning light brick?
11. How should the water and acid be combined?
12. How long does an acid solution retain its strength after it has been applied to the masonry structure?
13. What is sandblasting?
14. What should the sandblasting operator wear for personal protection?

L-2

Cleaning Old Masonry

Objectives*: After completing this assignment, you will be able to—*

1. *give the types of stains found on old masonry and*
2. *discuss the methods used for cleaning old masonry.*

Stains

Some stains that are found on new masonry are also found on old masonry. Efflorescence is common on both types, and the cleaning methods for it are relatively the same. Dried paint is also often found on old masonry, and may be removed by scrubbing with steel wool or by sandblasting. An exterior masonry surface that is not exposed to sunlight and that remains constantly damp may show signs of plant growth such as moss. This can be removed by applying ammonium sulfamate, available in most gardening supply stores under a commercial brand name. Directions on the proper way to apply the solution should be included.

Thoroughly scrub a smoke-stained surface with scouring powder and a stiff bristle brush. If this process does not clean the masonry, use trichlorothylene to pull the smoke stain from the pores of the material. Be sure that there is enough ventilation, however, because the fumes are harmful. Iron stains from hinges, wrought iron, or other metal fixtures are fairly common on old masonry. These stains may be removed by spraying or brushing the masonry with a strong solution of oxalic acid in water. Ammonium bifloride may also be added to the solution to speed up the reaction. There is the danger that the brick may become etched, so use care when applying the solution.

Cleaning Procedures

Cleaning by hand. When old masonry becomes dirty, the first thought is to attempt the cleaning process by hand. If the masonry has been kept clean periodically through the years, this operation will probably succeed. The work is usually done by using soap or detergent and cold water and scrubbing with a stiff brush. It is a slow process and should not be attempted on large jobs. It must also be done often to keep the masonry clean.

High-pressure water. High-pressure water cleaning is often used in the Midwest and on the Pacific Coast, but not in the industrial areas in the East. This process is successful, although the large volume of water necessary to clean the masonry can be a disadvantage. This method has not been used has much in the last few years, because of the possibility of a water shortage in the near future.

High-pressure steam. High-pressure steam is probably the most commonly used cleaning method. If the building is made of smooth, hard material with a glazed or vitreous surface (such as polished granite, marble, terra-cotta, or tile), it should always be cleaned with steam before any other method is tried. If a great number of stains have collected, a solution of detergent may be used with the steam.

Wet-sand cleaning. Wet-sand cleaning is used on hard brick, rough-finished limestone, and unpolished granite. This method uses a water-cushioned abrasive action that is used most often to remove paint or other surface coatings. Wet sand helps eliminate the dust that accompanies sandblasting.

Wet-aggregate cleaning. The wet-aggregate process is used on soft brick, sandstone, and limestone. It is especially effective for cleaning masonry containing carvings or other ornamentation. This process uses a mixture of water and aggregates that do not contain silica. It is sprayed at a low pressure through a special nozzle.

Chemicals and steam. Steam and chemicals under high pressure are used to remove coatings that have been applied to masonry at an earlier date. Paint, which is usually the material to be removed, will require special cleaning agents. A specialist does the cleaning because an analysis must be made to determine the chemicals that are needed.

Sandblasting. Although sandblasting was discussed in an earlier assignment, note that this method is quite effective for cleaning older materials. The masonry should be examined before this cleaning method is used because it may have softened or crumbled to a point where sandblasting might cause a great amount of damage.

Exercise

1. How may moss be removed from old masonry?
2. What materials are used for cleaning old masonry by hand?
3. What is the greatest disadvantage in using high-pressure water to clean masonry?
4. What masonry cleaning method is probably the most commonly used?
5. On what materials is the wet-sand cleaning method normally used?
6. What cleaning method is effective when carvings or ornamentation is involved?
7. What may be used to remove coatings that have been applied to masonry?
8. How should dry paint be removed from masonry?
9. What usually causes iron stain on old masonry?

M-1

Concrete-Block and Cut-Stone Trim

Objectives: *After completing this assignment, you will be able to—*

1. *discuss concrete-block construction and*
2. *discuss cut-stone construction.*

In concrete-block construction, a concave type of mortar joint is best. A rounded or V-shaped pointing tool is drawn along the joint after mortar begins to stiffen. This compacts the mortar and causes a tight, water-resistant joint. Vertical and horizontal joints are made 3/8 inch thick. If a portland cement stucco finish or plaster finish is used, the mortar is struck off flush with the masonry unit.

Set corner blocks first and stretch chalk lines tightly between them to serve as a guide in building the structure. If the corner blocks are accurately placed and plumbed, the line kept tight, and the block placed to the line, the wall will be straight and true. Use jamb blocks at window and door openings. After completing wall construction, place the frames for these openings in the recess allowed by the jamb block. Many times, jamb blocks are used at floor joists. Plates and sills are attached to concrete masonry walls by means of bolts that are 4 feet apart and extend through at least the top two courses. Secure the unit by using a large washer on the bolt and then filling concrete around the bolt.

Cut-Stone Trim

Limestone and marble contain a large percentage of calcium, or common lime. Limestone and sandstone are porous and loosely knit and will not last as long as granite, marble, and slate. Porous stones should not come into contact with the cement or mortar because it will pass through the stone and give the face a poor appearance. Porous stones are usually protected with a backing of nonstaining paint or lime mortar mixed with white nonstaining cement.

Because it is more expensive than brick or other backing materials, stone is cut in an ashlar veneer, which is 4 inches thick. It is usually held with variously shaped galvanized anchors. One end of each anchor is bent down 1 inch into the stone, and the other end in bent up 2 inches into the backing. Stones over 3 feet long should have two anchors. Cornice anchors for large projecting units are made specifically for each job. Clamps for parapet copings and baluster rails are normally made of galvanized flat iron, 1/4 by 1 1/4 inches and 6 to 12 inches long. Dowels are usually made of 1/2-inch pipe and are 3 inches long. They are constructed of either brass or iron, and the iron is galvanized after cutting. When wedges are needed to keep stones in place, wooden wedges should be used because they will not chip the stone. Most cut stone is estimated by the cubic foot. The stone is usually furnished by one contractor and set by another.

Cut-stone sills. Cut stone is probably the best sill material used on masonry walls. Because they are in one piece, sills may be cut as a lug or as a slip (fig. 1). A lug still does the best job because the lug is built under the jamb and is more watertight. Most lug sills are also cut with a wash, drip, and water bar. Lug sills are the easiest to set because they do not require any tilt. Slip sills are sawed square and have no particular thickness. They should be of brick heights in

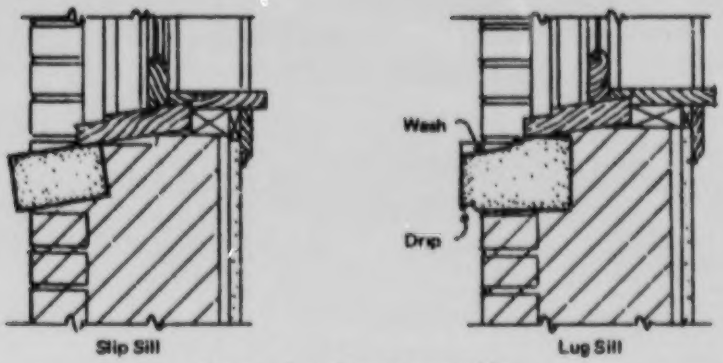

Wash
Drip
Slip Sill
Lug Sill

Figure 1. Cut-Stone Sills

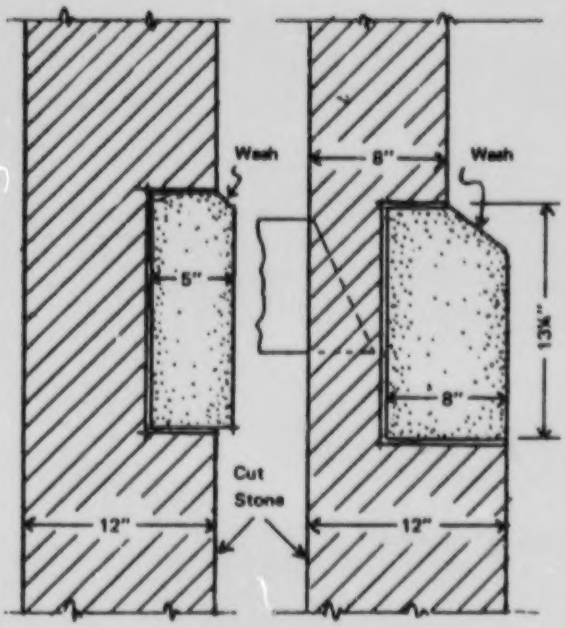

Wash
5"
8"
Wash
13¾"
8"
Cut
Stone
12"
12"

Figure 2. Stone Watertables

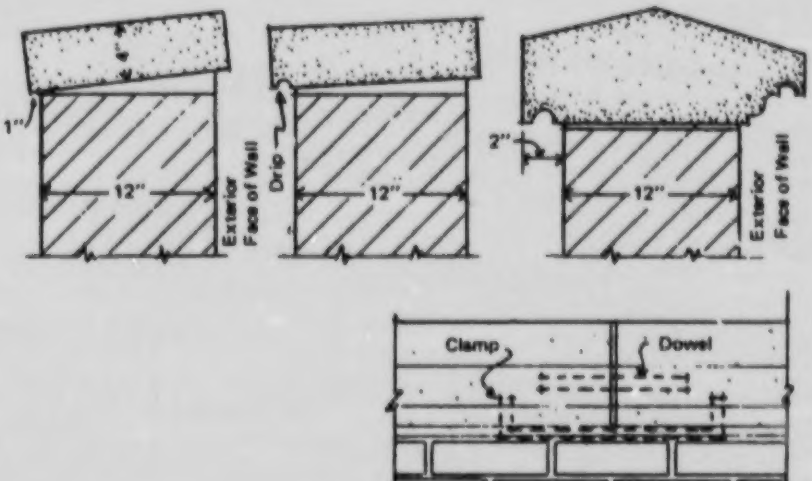

4"
1"
12"
Exterior
Face of Wall
Drip
12"
2"
12"
Exterior
Face of Wall
Clamp
Dowel

Figure 3. Cut-Stone Copings

thickness, and their width is governed by the width of the wall. All lug sills should be set on the wall before the frames are built in. While lug sills are normally placed on more expensive structures, slip sills are used on factory structures and less expensive housing.

Continuous cut-stone courses. Continuous belt, grade, and watertable courses add to a building's beauty as well as providing a distinct service. The grade courses appearing at the point where the foundation wall extends from the ground protect the brickwork or other masonry material used for the walls of the building. These courses also make up the difference of levels between the walls and the grade. Direct contact with the ground at this point requires a hard solid stone to withstand dampness that might seep through. The watertable (fig. 2) is another continuous course. It usually occurs at the first floor level. It acts as a setback in the wall for decorative purposes and removes rain from the face of the wall.

The sill or lintel courses may continue around the building or around that portion of the building that is trimmed with stone. A band or belt course may be placed at any level to help ornament the wall. It is not necessary for the stone to be a particular height since the courses are continuous for the entire facing. But, if they are broken, they should be in brick heights. Continuous courses may be flush or may project from the wall. If the stones are 4 inches thick, they must have stone anchors. This type of stonework should not have joints thicker than 1/4 inch.

Cut-stone coping. Cut-stone copings are either plain-sawed or molded (fig. 3). Cut-stone coping is designed to protect the walls beneath from the seepage of rain or melted snow. Cut stone is normally used where the job has other stone trim in the ornamentation. The function of coping is to shed water. It should tilt toward the roof side. This is done by placing a heavy bed of mortar on one side of the wall.

A plain-sawed stone may be used on fairly expensive jobs and may be laid without dowels and clamps. In more expensive jobs, all copings are either doweled or clamped to keep them from shifting. The dowels are placed at the ends of the stones, and the clamps are used on the underside. Drips may be placed on one or two sides to keep the water from seeping down to the face of the wall. Coping joints receive severe treatment from snow and rain, so the joints should always be grouted and pointed up with an elastic cement.

Cut-stone quoins. Quoins are stones used for ornamentation at corners. They may be plain or fancy and either flush with the wall or projected from it. Quoins are usually included at the corners when cut stone is used as trim on a building. Quoins should be considered ornamental stones and not strengthening devices. Being only 4 inches thick, they are not part of the wall, but as they become part of the wall in appearance, they must conform with brick lengths and heights. All cut-stone quoins must be anchored into the brickwork with stone anchors unless the stones are thicker than 4 inches. The stones should always have a bed and cross joint of 1 1/4 inch and be struck flush. The heights of stones should be any odd number of brick courses in elevation. This allows the brick under and over the stone lap to be a whole brick.

Exercise

1. What type of mortar joint is best for concrete-block construction?
2. Where are jamb blocks used in concrete-block construction?
3. How are stones protected from stains that may leak through from the back?
4. What is stone veneer called?
5. How many anchors are used for stones over 3 feet long?
6. What device is sometimes used to keep stones in place during setting?
7. What is the best sill material to use on masonry walls?
8. On what type of structures are lug sills usually placed?
9. Where does the watertable course usually appear?
10. What are two types of cut-stone copings?
11. How should coping joints be protected from severe weather?
12. What are quoins used for in stone construction?

M-2

Setting Stones

Objectives: *After completing this assignment, you will be able to—*

1. *discuss how dowels, anchors, and cramps are used in stone setting;*
2. *describe the props and temporary bracing needed when setting stone;*
3. *discuss how mortar joints are pointed; and*
4. *describe the methods to use in handling finished stonework.*

Setting Drawings

Where the setting of a number of stones is called for, a completely detailed setting drawing is required. This drawing shows elevations and sections of the job along with explanations telling how certain portions of the work are assembled and anchored. The setting drawing shows the dimensions of the stonework and the relationship between the finished lines of the stonework and other portions of the building. Items detailed in the setting drawing include the finished floor line, the finished line of plaster on walls and ceilings, the proposed finished grade line, the relationship between the stonework and metal or wood window frames, the position of window screens, and the relationship of wood or window sills with other wooden trim or paneling.

Dowels, Anchors, and Cramps

A wide range of temperatures makes masonry expand and contract. Unless the stones are securely bound together in proper alignment, a great deal of movement may occur. Mortar should not be depended upon solely for the bonding of the work. Dowels and anchors should also be used. The partial failure of many ancient masonry structures was caused primarily by a lack of understanding of a need for reinforcement and the failure to insert and build in metal anchors. Use dowels, anchors, and cramps that are made of a noncorrosive metal, or that are suitably protected by a permanent noncorrosive coating. Bronze rod or pipe dowels are first choice since they may be readily obtained. Cut dowels to the lengths required and have them available when the setting begins.

A cramp is another name for a type of anchor that secures two stones together rather than supplementing a bond by tying the stone securely into the backing or adjoining back masonry. Cramps are made of the same material as anchors except when they are used in exposed locations. Exposed locations usually require cast bronze. Sometimes keys of stone or slate, in the form of cubes, are used instead of cramps when only one form of alignment must be provided. These might be used in the base and top of balusters and columns, between joints in baluster rails, and in coping where the use of cramps is less desirable. Cramps should not be tightly fitted, but should be either solidly built and encased by a thoroughly filled mortar joint or grouted in structural-steel supports.

Sometimes the stonework of architectural features on a building is corbeled or bracketed out from the wall, or projects out so that the center of gravity of the particular stone—or the feature of which it forms a part—is beyond the face wall. When this occurs, the stone cannot be balanced on its mortar bed in the wall or pier that supports it. Walls are usually made as thin as possible within safe limits to prevent overturning from lateral pressure; therefore, it is frequently necessary to provide steel members either for carrying overhanging stonework or for anchoring it back to a sufficient area on the wall to assure its stability.

Props and Bracing

When stone projects considerably beyond the face of the wall, there is danger that it will overturn or compress the mortar bed. The stone must be temporarily propped in position until the mortar has had time to harden, and until the brickwork that is to be built on top of the stone feature as a part of the wall construction is completed. Props of wood or metal may be used. Their size depends on the weight of the stone that needs supporting. Props must be braced securely so that they will not slip out from under the stone. Therefore, props should be erected on a base large enough to spread the load over the ground or construction upon which they rest. They must also be set at an angle so that they can carry the load or be tied to the wall by tie braces. If the stone rests on top of a prop, the finished surface of the stone must not be damaged. Canvas or burlap is normally used to provide this protection.

Pointing Mortar Joints

A good durable pointing job depends more on skillful workmanship than on the materials used. Although good material is important, it never assures a good job. Good pointing remains in place free of shrinkage cracks, for a long time. Pointing includes cleaning out the joints, cutting the mortar out to a depth of at least 3/4 inch, and cleaning out the joint groove so that the pointing will be continuous. Dust should be brushed out and the mortar surfaces thoroughly moistened. Press the mortar firmly into the joint groove to force out all pocketed air and fill all interstices so that the pointing has a continuous bond with the setting mortar at the back.

Finish pointing flush with either the face of the stonework or with the stretch, and groove or bead where such joint finishes are desired. Use a tool that will not darken or discolor the pointing mortar.

Handling Finished Stonework

The appearance of finished stonework often depends on how the stone is unloaded from cars or trucks and how it is handled from the time it is unloaded to the time it is delivered to the building site. It should not be dumped on the ground. At the building site, the stonework should be placed on a platform blocked up several inches from the ground. It should be stacked on this platform either face up or with the face in a vertical position on wood laths, or strips. If the stone is stacked two or more courses high, 1-by-3-or 2-by-4-inch wood strips should be placed between the courses and the pile. The stacks should always be covered with waterproof material.

When stacking ornamental cut and carved pieces, use padding to protect the ornamental parts of the stone. Keep the stone clean at all times. If it becomes dirty during hauling or storage, wash it with scrub brushes or a steam hose before it is set. Prompt sponging of mortar droppings or splashes on the surface of finished work will add to the finished appearance.

Because nearly all acids have a detrimental effect on limestone and other types of stone, stonework must be protected from the solutions used for cleaning brickwork. It is best to drench the stonework with clean water promptly after the brickwork has been cleaned so that any cleaning solution that has fallen on the stone will be washed off. Acid-base solution should never be used for cleaning stonework.

If cut stone bearing cut or carved surfaces is lifted with ropes or belt slings, it should be protected with soft pads. Crowbars and pinch bars should be used as little as possible on stones, and then only on unexposed surfaces. Wedges should be of soft wood, and they should be thoroughly soaked overnight before use. Soaking causes wedges to swell so that as they dry they shrink and may be removed easily before the pointing is started. Snipping the edges of finished stone disfigures the appearance of the finished job.

Exercise

1. What does a stone-setting drawing contain?
2. What caused the partial failure of many ancient masonry structures?
3. From what material should dowels, anchors, and cramps be made?
4. What may be used instead of cramps when only one form of alignment must be provided?
5. On what does the size of props depend?
6. What type of pointing tool is used for building stone?
7. Where should stonework be placed at the building site?
8. What type of solutions should never be used for cleaning stones?
9. If crowbars or pinch bars must be used to handle stone, on what part of the stone should they be used?
10. What special treatment should wooden wedges receive before they are used?

N-1

Setting Up a Masonry Business

Objectives: *After completing this assignment, you will be able to—*

1. *explain the types of businesses that may be organized;*
2. *discuss the taxes and insurance a masonry business owner is responsible for paying and collecting;*
3. *explain what type of agreement or contract must be drawn up before starting a masonry job; and*
4. *discuss finances, personnel, and equipment needed by a masonry business owner.*

Types of Organizations

The owner of a masonry business can set up a business in several different ways. Sole ownership is the form used by most owners. The full responsibility for the company rests on one individual. No formal documents or agreements are necessary, and business and personal income may be the same for tax purposes.

A partnership agreement consists of individuals sharing responsibilities, liabilities, work, and profits. This agreement may combine the masonry experience of one person with the management abilities of another. A limited partnership usually consists of one person supplying the capital and the other person running the business.

A corporation involves more legal documents than a partnership, but gives tax and liability advantages. Business and personal income taxes are separated, which allows for tax advantages. If losses occur in a corporation, the owner or owners are liable for only part of those losses. Capital can also come from stockholders. An attorney should be retained to draw up the necessary legal documents.

Taxes

The masonry contractor or owner must obtain an employer's identification (EI) number from the Internal Revenue Service. This number is used on forms submitted with social security and federal income taxes that have been withheld from employees' salaries.

States with sales tax laws must also submit these taxes periodically. Sales tax laws concerning the masonry trades vary from state to state.

The business must pay federal unemployment taxes if it has paid wages of $1,500 or more in any calendar quarter (3 months), and if it had one or more employees on the payroll at least some portion of one day in each of 20 or more calendar weeks. The basic tax rate is 3.2 percent of the first $4,200 of taxable wages received by each employee. The actual rate to pay is much less because the federal government gives credit for unemployment taxes that are paid to the state government.

State government taxes are usually based on the taxable wage base of a quarter (3 months). The rate of the tax charged is also usually determined by the employee's unemployment experience. In some states the worker is also assessed taxed through payroll deductions.

Some counties, towns, and cities impose other taxes. These include taxes on gross receipts of businesses and unincorporated business taxes.

Insurance

A minimum amount of insurance must be carried by the masonry contractor or owner. This is designed to protect the workers and the owner from losses.

Worker's compensation covers liability if a worker is injured on the job. Some coverages also include driving to and from building sites.

Property insurance protects the contractor's property, materials, and equipment at either a central office or a building site.

Some masonry contractors furnish group insurance policies for their workers. The employer may pay for some or even all of the employee's insurance as a fringe benefit.

Contracts

No masonry construction should begin until a binding contract or agreement has been drawn up. This may be a contract with an owner of a house or building, a general contractor, or both. The contract should contain the price of the completed project, terms of payment, services, specifications, and time allowed for completion.

Financing the Business

Few masonry contractors can begin a business without acquiring additional capital. How much capital is needed depends on the type of masonry work to be done, the equipment that must be purchased, the number of employees that will be hired, the size and staff of an office, and the amount of money needed for the owner's living expenses.

Large jobs call for a large outlay of money, and loans are sometimes necessary at that time. The owner of a masonry business must build a good reputation for dependability so the risk to the lending institution is less.

The masonry contractor with sufficient capital can pay cash for materials and labor, and avoid paying interest on borrowed money. Sometimes cash discounts are allowed on materials. With sufficient cash on hand, the contractor can invest in equipment to save time and money.

The lending institution usually asks for a complete financial statement from the contractor. It may also ask for a personal resume if it has not done business with the contractor before.

Office

A large company must have an office or offices to keep up with all the necessary paperwork. Smaller contractors may work out of their homes. In this case, someone must always be near the phone to handle business calls. Many contractors now use the timesaving two-way radio or CB. The base unit is installed in the home or in the office. The contractor or other workers in the field make contacts through the base unit. Information is then relayed to other workers, the contractor, or to businesses that are supplying brick, stone, or other materials. This saves time-consuming trips.

Equipment and Materials

To be successful, the masonry contractor must spend a great deal of money for equipment. Although most workers will have their own hand tools, equipment such as hoists, scaffolds, cement mixers, wheelbarrows, stone-cutters, and so on, are furnished by the masonry contractor. Some contractors haul their own brick or stone, which requires large trucks. The contractor should buy materials from businesses that are reliable in supplying the proper materials and making deliveries as promised. Late material deliveries can disrupt the entire building program.

Personnel

A good labor force is essential when the masonry business owner begins operation. The new contractor usually has friends who are good at their work and want to get in on "the ground floor" of a new business. Workers must be selected carefully. Starting a new business with unreliable or too few employees can mean instant failure. An understaffed office or too few workers on the job soon makes scheduling impossible.

Exercise

1. What form of business ownership is used by most masonry owners?
2. What is a limited partnership?
3. Where does a masonry contractor or owner obtain an employer's identification number?
4. On what are state unemployment taxes usually based?
5. What does worker's compensation cover?
6. What are the advantages of the owner having sufficient cash on hand?
7. What device is used to relay information to the contractor, office, or workers on the job?
8. What does an understaffed operation cause?
9. What should be done before masonry construction begins?
10. Why should the owner of a masonry business build a good reputation for dependability?
11. What may disrupt an entire building program?

N-2

Human Relations in a Business

Objectives: *After completing this assignment, you will be able to—*

1. *discuss factors involved in the selection of personnel;*
2. *explain how to effectively train new employees; and*
3. *discuss the effects of good human relations and morale upon an employee's production.*

Selection of Personnel

A masonry contractor cannot afford to hire the wrong person for a particular job. The hiring must be done objectively and not emotionally. Just liking the applicant is not enough. Hiring must be based on the person's experience, attitude, and abilities that match the job.

First, the masonry contractor must be familiar with the duties and responsibilities of the position that is open. Most masonry contractors have at one time or another been involved in every phase of masonry work. This person usually knows how to operate all equipment and what steps to use in building with masonry. This makes it much easier to know how a certain individual can fill a specific position. It may help to have a complete description of the job to be filled.

When looking for new workers, a number of organizations can be helpful. State employment agencies, private employment agencies, recruiting firms, unions, and various social service organizations have leads on people wanting or needing jobs. The newspaper ad is often used to attract potential employees. Be as specific as possible with job requirements to avoid having to interview a great many unqualified people. One of the best ways to get new employees is through current employees. They can suggest names of people who are qualified and interested in working in masonry construction. If current employees are satisfied, they will be the best advertisement in attracting new employees.

The first step in evaluating potential employees is to check their backgrounds, An application form is the best source for some of that information. From this form it is possible to quickly determine if the applicant's education, training, and experience qualify the person for the position. For some jobs, it may be possible to train an individual to meet the standards of the job. Other jobs may require someone with many years of experience. For example, no contractor would hire an unskilled worker as a bricklayer. But, that worker could supply mortar to a qualified bricklayer.

Employers should have some type of interview, whether formal or informal, with the applicant. This allow an opportunity to ask important questions about particular phases of the work. The applicant may also have questions, and it is better to answer them before the person is hired. Do not expect miracles during the interview. Because the applicant is trying to make a good impression, it may be hard to get a clear picture of the individual.

Keep several steps in mind during the selection process:

1. Analyze the position.
2. Determine what abilities the employee must have to fill the job.
3. Study personal factors, such as age, education, and health of the applicant.

4. Write a complete job description.
5. Interview objectively.
6. Check all references.
7. Compile and review all information before making a final selection.

Employee Training

When they begin a new job, all employees should have an orientation period, during which the job should be explained in full. Although the person may have the background experience for a particular job, it may include responsibilities unique to that position. Give the employee an overview of the company policies and rules.

Some employees must go through a training period. The length of time needed for this training depends on the job responsibilities. For learning to take place during the training period, the employees must be able to learn at the level of the training program. The employees must also have the abilities and motivation needed to accomplish the job.

The trainers must organize their work to enable the new employees to learn. They must be patient and support the new workers during this learning period. The contractor or owner must support the training and give the trainer ample time to bring the new employees to the proper level of proficiency.

The training program should include information on safety. If employees learn safety from the beginning, they will form safety habits that may save time, expense, and suffering.

Be sure the trainers are competent. They must have the ability to communicate with others. Do not ask employees to train other people if they are opposed to the idea. They may only confuse the new worker. Ask other workers to support the training since they once had to go through it themselves. Check on the new employees periodically. Let them know that you are personally interested in their progress. Ask for suggestions that might make the training period easier.

Morale and Production

Good individual attitudes on the job lead to high group morale. When morale is poor, production always drops. It is very important for the contractor or owner to understand the viewpoints of the employees and to recognize if an individual or group problem exists. If some employees tend to pick on another individual, put a stop to this immediately. This tends to affect not only that individual, but also the company as a whole. Some employees are natural leaders. This means that they may lead other employees in to bad situations as well as good. A leader who stirs up trouble can disrupt a complete project. These problems can be headed off before they become a source of poor morale. A good contractor does not allow employees to "side" against groups or individuals.

Many people leave high-paying jobs because other factors cause dissatisfaction. Four primary factors that lead to good morale are:

1. satisfaction in the job itself;
2. pride in co-workers;
3. acceptance of pay policies and promotion opportunities; and
4. a feeling of belonging to the company.

High employee turnover, complaints, absenteeism, and low production are often indications of low morale. If any of these exist, immediately begin checking. Find out what is wrong before workers begin leaving.

There are many ways to improve human relations. One is to improve an understanding of human behavior. Accept the fact that some people do not look at things the same way others do. Respect differences of opinion. Be interested in all of the employees—not a select few. Correct poor conditions as soon as they become apparent. Keep employees informed, and give them a feeling of security. Promote from within the organization. Show good workers that their extra efforts are recognized. Offer only constructive criticism—and then only in private. Never criticize one employee to another employee. See that the supervisors are fair. Give only correct information. Above all, be fair.

Exercise

1. What must hiring be based on?
2. What organizations may be helpful in finding new employees for your company?
3. What is one of the best ways to get new employees?

4. What is the first step in evaluating potential employees?
5. Why is an interview important?
6. What is the last step in the selection process?
7. What should all employees have when they begin a new job?
8. What determines the length of the training period?
9. What characteristics should the trainer of new employees have?
10. Why should the trainer include safety in the training program?
11. Name the four primary factors that lead to good morale.
12. How does poor morale affect the company?
13. What are indications of low morale?

Glossary

Absorption—the amount of water a brick or tile unit absorbs when immersed in either cold or boiling water for a stated length of time.

Absorption rate—the weight of water absorbed when a brick is partially immersed for one minute; usually expressed in either grams or ounces per minute.

Abutment—a supporting wall that carries the end of a bridge or span and holds the pressure of the abutting soil.

Admixtures—materials added to mortar for color or to retard or quicken setting.

American bond—a bond consisting of from five to seven stretcher courses between headers.

Anchor—a piece or assembly used to attach building parts to masonry or masonry materials; usually metal.

Arch—a curved, compressive, structural member spanning openings or recesses; many also be built flat.

- **Back arch**—a concealed arch carrying the backing of a wall where the exterior facing is carried by a lintel.
- **Jack arch**—an arch with horizontal or nearly horizontal upper and lower surfaces.
- **Relieving arch**—an arch built over a lintel, a flat arch, or a smaller arch to divert loads that relieves the lower member from excessive loading.
- **Trimmer arch**—an arch used for supporting a fireplace hearth; usually a low rise arch of brick.

Architectural terra-cotta—a hard-burned, glazed or unglazed clay building unit that may be plain or ornamental and is normally larger in size than bricks or facing tile.

Ashlar masonry—masonry composed of rectangular units of burned clay, shale, or stone; generally larger in size than brick and properly bonded with sawed, dressed, or squared beds and joints laid in mortar.

ASTM—American Society for Testing Materials.

Back filling—rough masonry built behind a facing or between two faces; also a filling over the extrados of an arch.

Backup—the part of a masonry wall behind the exterior facing.

Bat—a piece of brick.

Batter—recessing of sloping masonry back in successive courses.

Bearing wall—a wall that supports the floors and roof in a building.

Bed joint—the horizontal layer of mortar on which a masonry unit is laid.

Belt course—a narrow continuous horizontal course of masonry; sometimes used for window sills.

Blocking—a method of bonding two adjoining or intersecting walls that are not built at the same time by means of offsets whose vertical dimensions are not less than 8 inches.

Bond—tying various parts of a masonry wall together by lapping units one over another or by connecting with metal ties; also the patterns formed by the exposed faces of units; may be adhesion between mortar or grout and masonry units or reinforcement.

Bond course—the course consisting of units that overlap more than one wythe of masonry.

Bonder—a bonding unit.

Breaking joints—any arrangement of masonry units that prevents continuous vertical joints from occurring in adjacent courses.

Brick—a solid masonry unit of clay or slate that is formed into a rectangular prism while plastic and burned or fired in a kiln.

- **Acid-resistant brick**—brick suitable for use with chemicals; usually in conjunction with acid-resistant mortars.
- **Adobe brick**—large roughly molded, sun-dried clay brick of varying sizes.
- **Angle brick**—any brick shaped to an oblique angle to fit a salient corner.
- **Arch brick**—wedge-shaped brick for special use in an arch; extremely hard-burned brick from an arch of a scove kiln.
- **Building brick**—brick for building purposes not especially treated for texture or color.
- **Clinker brick**—a very hard-burned brick whose shape is distorted or bloated due to nearly complete vitrification.

Dry-press brick—brick formed in molds under high pressures from relatively dry clay.

Economy brick—brick whose nominal dimensions are 4 inches by 4 inches by 8 inches.

Engineered brick—brick whose nominal dimensions are 3 1/5 inches by 4 inches by 8 inches.

Facing brick—brick made especially for facing purposes; often treated to produce surface texture; made of specific clays or treated to produce the desired color.

Firebrick—brick made of refractory ceramic material that resists high temperatures.

Floor brick—smooth dense brick, highly resistant to abrasion and used for finished floor surfaces.

Gauged brick—brick ground or otherwise produced to accurate dimensions; also a tapered arch brick.

Jumbo brick—a brick larger than the standard brick.

Norman brick—brick whose nominal dimensions are 2 2/3 inches by 4 inches by 12 inches.

Paving brick—a vitrified brick especially for use in pavements where resistance to abrasion is important.

Roman brick—brick whose nominal dimensions are 2 inches by 4 inches by 12 inches.

Salmon brick—a relatively soft, underburned brick named for its color.

Sewer brick—low-absorbent, abrasive-resistant brick used for drainage structures.

Brick and brick—a method of laying brick so that units touch each other with only enough mortar to fill surface irregularities.

Bull header—a brick laid on its edge showing only the end on the face of the wall.

Bull stretcher—a brick laid on its edge showing the broad side of the brick on the face of the wall.

Buttering—placing mortar on a masonry unit with a trowel.

Buttress—a vertical projecting piece of stone or brick masonry built in front of a wall to strengthen it.

Capacity insulation—the ability of masonry to store heat as a result of its mass, density, and specific heat.

C/B ratio—the ratio of the weight of water absorbed by a masonry unit during immersion in cold water to the weight absorbed during immersion in boiling water.

Cement—a burned mixture of clay and limestone ground for mortar or concrete.

Centering—temporary formwork for the support of masonry arches or lintels during construction.

Ceramic color glaze—an opaque-colored glaze of satin or gloss finish obtained by spraying the clay body with a compound of metallic oxides, chemicals, and clays.

Ceramic veneer—architectural terra-cotta characterized by large face dimensions and thin sections.

Adhesion-type ceramic veneer—thinner sections of ceramic veneer held in place by adhesion of mortar to unit and backing; metal anchors not required.

Anchored-type ceramic veneer—thicker sections of ceramic veneer held in place by grout and wire anchors that are connected to a backing wall.

Chase—a continuous recess built into a wall to receive pipes and ducts.

Chimney—a vertical shaft built to carry off smoke.

Clay mortar-mix—finely ground clay used as a plasticizer for masonry mortars.

Clip—a portion of a brick cut to length.

Closer—the last brick or tile laid in a course; may be either a whole unit or a portion of a unit.

Closure—supplementary or short-length units used at corners or jambs to maintain bond patterns.

Code (building)—a group of laws or regulations governing the workmanship, materials, and location during the construction of buildings.

Collar joint—the vertical, longitudinal joint between wythes of masonry.

Common bond—a number of brick courses of stretchers followed by one course of either Flemish or full headers.

Coping—the material or masonry units that form a cap or finish on top of a wall, pilaster, pier, or chimney; serves to protect the masonry below from water penetration.

Corbel—a shelf or ledge formed by projecting successive courses of masonry out from the face of the wall.

Cornice—the projection at the top of a wall finished by a blocking course.

Course—one of the continuous horizontal layers of units bonded with mortar in masonry

Cramp—a bar of iron whose ends are turned at right angles to the body or the bar so that it may enter holes in the faces of adjacent stones.

Damp course—a course or layer of impervious material that prevents capillary entrance of moisture from the ground or a lower course.

Dentil—cogged or toothlike units that project beneath a cornice and give a decorative effect.

Dog's tooth brick laid with the corners projecting from the wall face.

Dowels—straight metal bars used to connect sections of masonry materials.

Drip—a projecting piece of material shaped to drain water and prevent it from running down the face of the wall.

Dutch bond—a method of arranging bricks so that a header is the second brick in every alternate stretching course and a three-quarter brick begins the other stretcher courses.

Efflorescence—a powder or stain sometimes found on the surface of masonry resulting from deposition of water-soluble salts.

English bond—a method of arranging bricks with alternate courses of headers and stretchers.

Extrados—the outer or upper surface of an arch.

Expansion joint—a vertical space or joint that allows for expansion and contraction caused by temperature changes.

Facing—any material used as a finished surface; usually forming part of a wall.

Field—the expanse of wall between openings and corners composed primarily of stretchers.

Filter block—a hollow, vitrified clay masonry unit, sometimes salt-glazed, designed for trickling filter floors in sewage disposal plants.

Fireproofing—any material protecting structural members to increase their fire resistance.

Flashing—a thin impervious material placed in mortar joints and through air space in masonry to prevent water penetration; also provides water drainage.

Flemish bond—a method of arranging bricks so that headers and stretchers are alternated in each course with the header in the center of the stretcher above and below.

Flue—a passage in a chimney that is used for an escape for smoke and gases.

Frog—a depression in the bed surface of a brick.

FTI—Facing Tile Institute.

Furring—a method of finishing the interior face of a masonry wall to provide space for insulation and a level surface for finishing and to prevent moisture from being transmitted.

Gothic arch a pointed arch made of two segments whose points meet at the crown.

Grout—a material with a high water-cement ratio normally poured into spaces within masonry walls; usually made up of portland cement, lime, and aggregates.

Hacking—the procedure of stacking brick in a kiln or on a kiln car; also laying brick with the bottom edge set in from the plane surface of a wall.

Hard-burned—nearly vitrified clay products that have been fired at high temperatures.

Head joint—the vertical mortar joint between ends of masonry units; sometimes called a cross joint.

Header—a masonry unit that overlaps two or more adjacent wythes of masonry to tie them together.

  Blind header—a concealed brick header in the interior of a wall that does not show on the faces.

  Clipped header—a bat placed to look like a header for purposes of establishing a pattern.

  Flare header—a header of darker color than the field of the wall.

Heading course—a continuous bonding course of header brick.

Herringbone bond—a method of arranging bricks in an angular or zigzag manner resembling the bone structure of a herring.

High-lift grouting—the technique of grouting masonry in lifts up to 12 feet.

Intrados—the lower curve of a right section of an arch that is perpendicular to the axis.

Keystone—the center brick or stone of an arch.

King closure—a brick cut diagonally to have one 2-inch end and one full-width end.

Lateral support—a method of bracing walls either vertically or horizontally by beams, floors, roofs, or columns.

Lead—the section of a wall built up and racked back on successive courses.

Lime (hydrated)—quicklime with sufficient water to convert the oxides to hydroxides.

Lime putty—hydrated lime in plastic form ready for addition to mortar.

Lintel—a beam placed over an opening in a wall.

Masonry—brick, tile, stone, or other materials bonded with mortar.

Masonry cement—a plant-mixed mortar requiring the addition of sand and water.

Masonry unit—natural or manufactured building units of burned clay, stone, glass, gypsum, and so forth.

  Hollow masonry unit—a unit whose net cross-sectional area in every place parallel to the bearing surface is less than 75 percent of the gross.

  Modular masonry unit—a unit whose nominal dimensions are based on the 4-inch module.

  Solid masonry unit—a unit whose net cross-sectional area in every place parallel to the bearing surface is 75 percent or more of the gross.

Mortar—a plastic mixture of materials that are cement in nature, fine aggregates, and water.

Mortarboard—a board about 3 feet square that is laid on the scaffold and holds the mortar.

Mortar box—a container in which the mortar is mixed before use.

Nominal dimension—a dimension greater than a specified masonry dimension by the thickness of a mortar joint; not more than 1/2 inch.

Outrigger—a joist that projects out of a window; used for supporting an outside scaffold.

Partition—an interior wall one story or less in height.

Pargeting—the process of applying a coat of cement mortar to masonry.

Pick and dip—a process of using one hand to pick up a brick and the other hand to pick up mortar with the trowel.

Pier—an isolated column of masonry.

Pilaster—a wall portion that projects from either or both wall faces and serves as a vertical column.

Plinth—the square block serving as a base for a column or pedestal.

Pointing—troweling mortar into a joint after masonry units are laid.

Portland cement—a cement made from clays, limestone, chalk, and slate that are mixed together, burned, and ground into a powder.

Queen closure—a cut brick having a nominal 2-inch horizontal face dimension.

Quoin—a projecting right-angle masonry corner.

Racking—a method of stepping back successive courses of masonry.

RBM—reinforced brick masonry or reinforced clay masonry.

Reinforced masonry—masonry units, reinforcing steel, grout, and mortar that are combined to act together in resisting various forces.

Rowlock—a brick laid on its face edge so that the normal bedding area is visible in the wall face.

SCR—Structural Clay Research.

Segmental arch—a type of arch where intrados and extrados make the line of a half circle.

Shoved joints—vertical joints filled by shoving a brick against the next brick when it is being laid in a bed of mortar.

Smoke chamber—the opening in a fireplace above the throat where smoke is gathered before it passes into the flue.

Soldier—a stretcher set on end with the face showing on the wall surface.

Stack—any structure or part of a structure that contains a flue for the discharge of gases.

Story pole—a marked pole for measuring masonry coursing during construction.

Stretcher—a masonry unit laid with its greatest dimension horizontal and its face parallel to the wall face.

Stringing mortar—the procedure of spreading enough mortar on a bed to lay several masonry units.

Struck joint—any mortar joint finished with a trowel.

Temper—to moisten and mix clay, plaster, or mortar to the desired consistency.

Tie—any unit of material that connects masonry to masonry or other materials.

Tile (structural clay)—hollow masonry building units composed of burned clay, shale, fireclay, or other mixtures.

- **Toothing**—constructing the temporary end of a wall with the end stretcher of every alternate course projecting.
- **Trig**—a device used in the middle of a wall to hold the line and keep the line from sagging.
- **Tuck pointing**—the filling in of fresh mortar where there are defective joints in the masonry.
- **Veneer**—a single wythe of masonry used for facing purposes.
- **Vitrification**—the condition resulting when kiln temperatures are sufficient to fuse grains and close pores of a clay product; this causes the mass to be impervious.
- **Wall**—a vertical, platelike member that encloses or divides space.
  - **Apron wall**—the part of a panel wall between the windowsill and the wall support.
  - **Bearing wall**—a wall that supports a vertical load in addition to its own weight.
  - **Exterior wall**—any outside wall or vertical enclosure of a building other than a party wall.
  - **Fire division wall**—a wall that subdivides a building so it will resist the spread of fire.
  - **Fire wall**—a wall that subdivides a building so it will resist the spread of fire and that extends continuously from the foundation through the roof.
  - **Hollow wall**—a wall built of masonry units arranged to provide air space within the wall.
  - **Panel wall**—a nonbearing wall in skeleton-frame construction wholly supported at each story.
  - **Parapet wall**—the part of any wall entirely above the roof line.
  - **Party wall**—a wall used for joint service by adjoining buildings.
  - **Solid masonry wall**—a wall built of solid masonry units with the joints between units completely filled with mortar.
- **Wall plate**—a horizontal member anchored to a masonry wall to which other structural elements may be attached.
- **Wall tie**—a bonder or metal piece connecting wythes of masonry to each other or to other materials.
- **Watertable**—a projection of lower masonry on the outside of the wall slightly above the ground.
- **Weep holes**—openings placed in mortar joints of facing material at the level of flashing to permit the escape of moisture.
- **Wire-cut brick**—a brick with surfaces formed by wires while the clay is still soft.
- **Wythe**—each continuous vertical section of masonry 1 unit thick.

7

Bricklayer and Stonemason

Instructor's Guide

U.S.O.E. 46.0102
D.O.T. 861.381, 861.781, 861.884

By

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Published by

Extension Instruction and Materials Center
Division of Continuing Education
The University of Texas at Austin

Developed under a contract with

Department of Occupational Education and Technology
Texas Education Agency
Austin, Texas

1984

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Printed in the United States of America

Brand names, company names, trademarks, or other identifying symbols appearing in the illustrations and/or text are used to clarify and identify and do not constitute a recommendation or endorsement by the author or the publisher.

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Stock Number IE 312 C

Contents

Foreword / **v**

Acknowledgments / **vi**

Notes for the Instructor / **vii**

Answers to Exercises / **1**

Answers to Assignment Tests / **21**

Assignment Tests and Work Sheet / **27**

COMPLIANCE STATEMENT

TITLE VI, CIVIL RIGHTS ACT OF 1964; THE MODIFIED COURT ORDER, CIVIL ACTION 5281, FEDERAL DISTRICT COURT, EASTERN DISTRICT OF TEXAS, TYLER DIVISION

Reviews of local education agencies pertaining to compliance with Title VI Civil Rights Act of 1964 and with specific requirements of the Modified Court Order, Civil Action No. 5281, Federal District Court, Eastern District of Texas, Tyler Division are conducted periodically by staff representatives of the Texas Education Agency. These reviews cover at least the following policies and practices:

(1) acceptance policies on student transfers from other school districts;

(2) operation of school bus routes or runs on a non-segregated basis;

(3) nondiscrimination in extracurricular activities and the use of school facilities;

(4) nondiscriminatory practices in the hiring, assigning, promoting, paying, demoting, reassigning, or dismissing of faculty and staff members who work with children;

(5) enrollment and assignment of students without discrimination on the basis of race, color, or national origin;

(6) nondiscriminatory practices relating to the use of a student's first language; and

(7) evidence of published procedures for hearing complaints and grievances.

In addition to conducting reviews, the Texas Education Agency staff representatives check complaints of discrimination made by a citizen or citizens residing in a school district where it is alleged discriminatory practices have occurred or are occurring.

Where a violation of Title VI of the Civil Rights Act is found, the findings are reported to the Office for Civil Rights, Department of Health, Education and Welfare.

If there is a direct violation of the Court Order in Civil Action No. 5281 that cannot be cleared through negotiation, the sanctions required by the Court Order are applied.

TITLE VII, CIVIL RIGHTS ACT OF 1964: EXECUTIVE ORDERS 11246 and 11375; TITLE IX 1973 EDUCATION AMENDMENTS: REHABILITATION ACT OF 1973 AS AMENDED; 1974 AMENDMENTS TO THE WAGE-HOUR LAW EXPANDING THE AGE DISCRIMINATION IN EMPLOYMENT ACT OF 1967; VIETNAM ERA VETERANS READJUSTMENT ASSISTANCE ACT OF 1972 AS AMENDED IN 1974.

It is the policy of the Texas Education Agency to comply fully with the nondiscrimination provisions of all federal and state laws and regulation by assuring that no person shall be excluded from consideration for recruitment, selection, appointment, training, promotion, retention, or any other personnel action, or be denied any benefits or participation in any programs of activities which it operates on the grounds of race, religion, color, national origin, sex, handicap, age, or veteran status (except where age, sex, or handicap constitute a bona fide occupational qualification necessary to proper and efficient administration). The Texas Education Agency makes positive efforts to employ and advance in employment all protected groups.

Foreword

This publication is one of the Extension Instruction and Materials Center series of individualized instructional materials. Students using this material can work at their own pace, enabling them to concentrate on areas that best fit specific needs. The design of the instruction makes it possible to relate work experience with materials studied at school.

Although the material is designed for individualized study, it should be used under the supervision of an instructor. For that reason, two basic publications are offered—a student's manual and an instructor's guide.

The **student's manual** is for the use of the person in training. It includes assignments, objectives that tell what the student is to learn from each assignment, and exercise questions that can help in meeting those objectives.

The **instructor's guide** has additional information that may help the instructor help the student. There are suggestions on how the student should use the student's manual, and how the instructor can coordinate work experience with learning at school. The instructor's guide also contains (1) answers to exercise questions and assignment test questions, (2) one set of assignment tests, and (3) a work sheet that the instructor can use to relate instruction to job experience for the student.

Although both publications are copyrighted, the instructor should feel free to reproduce the tests and work sheet. These have been placed in a separate section of the guide, where they are readily accessible for copying. If the instructor prefers, copies of this section can be ordered separately for individual students from Extension Instruction and Materials Center, The University of Texas at Austin, P.O. Box 7218, Austin, Texas 78713.

Every effort has been made to produce a publication that addresses the unique needs of our current student population. Students with limited English proficiency (LEP) as well as handicapped, educationally disadvantaged, and nontraditional students may require modification of the material in this publication. The professional staff of EIMC will gladly work with any instructor having these students to show how the instructional material can be adapted for specific individualized instruction. Consult local, state, and federal agencies that offer assistance and guidance and that can provide sound recommendations for productive classroom management.

Kathryn R. Allen, Ph.D.
Acting Director, Extension Instruction and
Materials Center

Acknowledgments

The Extension Instruction and Materials Center of The University of Texas at Austin wishes to acknowledge with grateful appreciation the cooperation and generosity of The Brick Institute of America, The Goldblatt Tool Company, Masonry Specialty Company, and the U.S. Dept. of Agriculture, Farmer's Bulletin #1889 for the use of illustrations and source materials.

We also appreciate the time and effort spent by James R. Wise, business agent, International Union, Bricklayers and Allied Craftsmen, Local #8 of Austin, Texas, in validating this publication.

Notes for the Instructor

The instructor's guide is provided to help you make certain that each student gets the most benefit possible from both the student's manual and his or her work on the job. To do so, this guide includes—

1. notes for the instructor;
2. answers to assignment exercises;
3. answers to assignment tests;
4. assignment tests, in the form in which they will be used by the student; and
5. a work sheet for planning and recording work experiences and related assignments from the student's manual.

These notes and all answers to exercises and test questions should be kept by the instructor. The actual assignment tests and the work sheet may be removed to be used or reproduced. For convenience, this guide is punched for notebook use.

Occupational Requirements and Student Background

The contents of the student's manual are related to the occupational titles of bricklayer and stonemason in the U.S. Department of Labor's Dictionary of Occupational Titles (1977).

Students learning to be bricklayers or stonemasons should have a high mechanical aptitude and high degree of manual dexterity. They must have good eyesight and be able to lift and handle moderate weights. They must also be able to read and interpret manufacturer's literature, construction blueprints, and other instructions. They should have a basic knowledge of simple arithmetic, fractions, and decimals.

Assignment Design and Teaching Principles

The student's manual presents related technical information to (1) groups of trade and industrial students with various vocational objectives and (2) homogeneous groups in which the learning levels of individual students vary considerably. The student's manual is not intended to be used as a correspondence course. Instead, it must be used by students under the direct supervision of an instructor.

Each assignment in the student's manual is designed to use as many fundamental teaching principles as possible. For that reason, each assignment is broken down into four parts—objectives, technical information, exercise, and test.

Objectives. The first teaching principle is that the student should be informed at the outset what should be learned from an assignment. The statement of objectives for an assignment is based on this principle. These are performance objectives that can be tested when the assignment is completed.

Technical Information. The second teaching principle is that technical information should be presented in a complete but concise form. All the information needed to complete the assignment exercise and meet the objectives is found in the assignment itself. This information has been organized to help the student learn more easily—either step by step, moving from simple to complex, or by logical topics and subtopics.

Exercise. The third teaching principle is that technical information is learned better if it can be applied as soon as possible after it is presented. This is done through the use of exercise questions for each assignment. The exercise questions are phrased to bring out key points and to aid in evaluating the technical information. The instructor should emphasize to students that both the objectives and the technical information should be read before they attempt to answer the questions in the exercise. An exercise is not an open-book test, and this idea should be discouraged. The answers may be useful in helping a student who is having difficulty with an assignment test.

Test. The fourth major teaching principle is that the effectiveness of an assignment should be evaluated. This is made possible by brief assignment tests provided in this guide. A test should be given when an assignment is completed. Each assignment test is based on the objectives stated for that assignment.

The answers to both assignment exercises and assignment tests have been made as brief as possible to make it easier for the instructor to check the student's classroom work quickly and accurately. All answers should be retained by the instructor for obvious reasons.

Tests and Work Sheet

The last section of this guide contains the tests and work sheet that can be removed for reproduction or other uses. The tests and work sheet may be reproduced without the publisher's permission. Sets of the material in the last section can also be ordered separately from this Center.

Answers to Exercises

Exercise A-1

How to Use This Manual

---

1. technical instructions, procedures, and illustrations
2. the combination of classroom study and on-the-job experience
3. (1) objectives
   (2) information
   (3) exercise
   (4) test
4. before reading the information part of the assignment
5. Read the information and study the illustrations.
6. tools and materials, as well as certain procedures and operations
7. when answering the exercise questions or when certain on-the-job tasks make it necessary
8. to help the student meet the objectives
9. in complete sentences
10. Correct any mistakes and place the papers in their notebooks.
11. when the exercise questions have been answered correctly
12. make students think
13. as soon as an assignment is completed, or, several tests may be combined as a weekly or six-weeks' test
14. fill-in-the-blank and multiple-choice

Exercise A-2

Careers in the Masonry Field

---

1. walls, walks, patios, partitions, fireplaces, and other structures
2. limestone, granite, and marble
3. churches, hotels, and offices; also on houses where stone is plentiful
4. mortar
5. filling cracks with mortar or removing and replacing damaged brick or stone
6. in businesses operated by trade, building, or general contractors
7. 3 years of on-the-job training and 144 hours of classroom instruction
8. at least 17 years old
9. Growth will be slower than that of other industrial occupations.
10. less likely to be injured
11. long periods of standing, kneeling, or stooping, heavy lifting; injuries from hand tools, bricks, and stones; falls from scaffolds; few job openings; and lost time due to poor weather conditions

Exercise B-1

Adding and Subtracting Common Fractions

---

1. a part of a whole
2. as 1/4
3. two sixths (2/6)
4. the numerator
5. the denominator
6. finding the lowest common denominator
7. an improper fraction
8. those containing both a whole number and a proper fraction
9. the lowest number into which the denominator of each of the fractions you want to add or subtract will divide evenly
10. A whole number is borrowed and added to the smaller fraction.
11. (1) 5/12
    (2) 19/21
    (3) 7/8
    (4) 19/35
    (5) 5/18
12. (1) 3/8
    (2) 19/40
    (3) 5/12
    (4) 1/18
    (5) 31/63

Exercise B-2

Multiplying and Dividing Common Fractions

---

1. a number that is multiplied by another number
2. a number that is used to multiply another number
3. Multiply the numerator of the fraction by the whole number, and then divide the result by the denominator.
4. Multiply the numerator of one fraction times the numerator of the other. Multiply the denominators also.
5. a number by which a divident is divided
6. The denominator of the fraction is multiplied by the whole number.
7. turning the fraction upside down
8. (1) 9/14
   (2) 3/40
   (3) 2 2/3
   (4) 1/10
9. (1) 2
   (2) 2
   (3) 11/12
   (4) 8/9

Exercise B-3

Decimal Fractions and Conversions

---

1. as decimal fractions
2. 0.003
3. (1) 30.5
   (2) 14.343
4. (1) 7.2
   (2) 50.70
5. Multiply as if you were multiplying whole numbers. Mark off to the left as many decimal places in the product as you have in both the multiplier and the multiplicand.
6. (1) 0.183
   (2) 1.2496
7.

```
      2
2.8)5.6
    5.6
      0
```

8. (1) 0.5
   (2) 0.375
   (3) 0.166
   (4) 0.6
9. (1) 1/2
   (2) 3/4
   (3) 7/400
   (4) 19/400

Exercise B-4

Percentage, Ratio, and Proportion

---

1. (1) 5/100
   (2) 1/5
   (3) 2/5
2. (1) 75%
   (2) 10%
   (3) 15%
3. (1) 1:20
   (2) 1:5
4. (1) 10%
   (2) 4%
5. (1) 0.08
   (2) 0.87
   (3) 0.03
6. (1) 8%
   (2) 17%
   (3) 98%
7. the statement of an equal relationship between two ratios or fractions
8. the numerator
9. Multiply the fraction by 100 and add the percent sign.

Exercise B-5

The Metric System

---

1. One meter is one ten-millionth of the distance from the equator to one of the poles.
2. 0.27 liters
3. 2.205 pounds = 1 kilogram
   12÷2.205 = 5.44 kilograms
4. 3.6 kilometers
5. 28.35 grams
6. 39.37 inches
7. 1.057 quarts
8. 1 gallon = 3.785 liters
   3.785 x 5 = 18.925 liters
9. the gram
10. 1 ounce = 28.35 grams
    28.35 x 9 = 255.15 grams

Exercise B-6

Developing Areas, Perimeters, and Circumferences

---

1. 144 square feet
2. 80 square feet
3. 153 square feet
4. 540 square feet
5. 176.72 feet
6. 46 feet
7. 80 feet
8. 50.27 feet
9. 50.27 feet

Exercise C-1

General Safety

---

1. They might be jarred loose or collapse under the additional weight.
2. acid
3. serious damage to the blood, lungs, kidney, and gastrointestinal system
4. skin contact
5. a NIOSH-approved respirator
6. Immediately check the seal, the filter, and the cartridge, and replace if needed.
7. the use of power equipment with noise levels in excess of NIOSH standards (currently 90 decibels)
8. the type of noise, the frequency of the noise, and how well they fit the individual

9. when there is a possibility of an eye injury from flying particles, chips, and caustic materials
10. (1) goggles
    (2) face shields
11. hard hats and hard-toed shoes
12. so you can see any cracks or flaws that might develop
13. near energized electrical equipment
14. The base of the ladder should be one-fourth of its working length away from the wall or support.
15. toward the ladder
16. during storms or high winds, or when scaffolds are covered with ice or snow

Exercise C-2

Handling and Storage

---

1. while materials are being handled
2. when materials being handled are heavy or sharp or likely to cause damage if dropped
3. the hands and the legs
4. at a given signal
5. only authorized persons
6. when carrying, lifting, or moving objects that are sharp, splintery, or hazardous to bare hands
7. rings
8. a squatting position
9. in glass containers in low locations, such as bottom shelves

Exercise C-3

Hand and Power Tool Safety

---

1. in a sheath or tool belt
2. because forcing a dull cutting tool often causes accidents
3. (1) missing the chisel and hitting a finger or hand
   (2) when particles from mushroomed heads fly off
4. flat, dry, and slightly rough
5. goggles or a face mask
6. during removal, replacement, and sharpening of the blades
7. a respirator
8. Since the cement mixer is often top-heavy, it should be on level ground and in a stable position.
9. It is hard to control on slopes or when trying to stop.

Exercise D-1

Reading Blueprints

---

1. both short and long dashes
2. to indicate the outside borders and edges or lines that are visible within the object
3. to allow a space for dimension numbers
4. to identify numbers, notes, or references with a particular line, opening, or detail
5. break lines
6. phantom lines
7. when there is not enough room on the drawing to show a complete object
8. those that show the openings in walls and the materials to use
9. Sheets are added that are drawn at a larger scale.
10. a cutaway of an object, building, or part of a building
11. the true shape of an object and its relationship to other parts
12. the dimensions of the unit in question

Exercise D-2

Angles and Shapes

---

1. a triangle used on a T square
2. (1) the acute angle
   (2) the obtuse angle
   (3) the right angle
3. one that has two equal sides and two equal angles
4. A chord is a straight line that connects one edge of a circle to another. It can, but does not necessarily have to, cross the center.
5. one that encloses another figure
6. a figure with opposite sides that are parallel
7. a figure with parallel sides of different lengths and with no 90-degree angles
8. one where the sides of the prism meet the base at an angle of 90 degrees
9. by moving a straight line in a circular motion
10. polygon bases

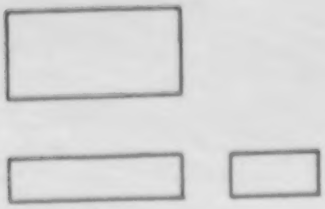
Exercise D-3

Types of Drawings

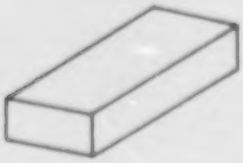
---

1. top, front, and side or end views
2. directly below the top view

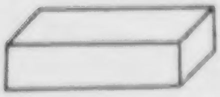
3.



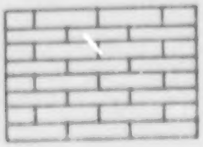
4. at 30 degrees to the horizontal plane
5.



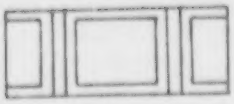
6. the front dimension
7.



8. a perspective drawing
9. one-point and two-point
10. the various sides as they would be seen by an individual directly in front of each side
11.



12.



Exercise E-1

Trowels, Hammers, and Chisels

1. the trowel
2. (1) Philadelphia
   (2) London
3. making as few movements as possible
4. a mortar tub or board
5. four
6. It is cut off with the trowel and used on the next joint.
7. For the bricks that absorb moisture readily, wetting adds moisture back to the brick so that a good bond is formed.
8. making rough breaks on the brick, driving nails, and striking chisels or brick sets
9. The tile hammer is smaller and weighs less than the brick hammer.
10. the blocking or bolster chisel
11. (1) convex jointer
    (2) V jointer
    (3) concave stone beader
    (4) raker jointer

Exercise E-2

Measuring and Leveling Tools

1. to lay out a corner or story pole and to lay out arches over openings
2. for keeping jambs and corners square and for marking brick for cutting
3. vertical and horizontal
4. to set soldier courses and rowlock sills and to start corners
5. a masonry guide or story pole
6. each time a course is finished
7. a trig
8. a story pole
9. 10 feet

Exercise E-3

Mixing and Smoothing Tools

1. to hold mortar that is being picked up with a trowel to use directly on the masonry
2. It quickly dries and hardens.
3. a V-shaped box for carrying mortar
4. It has two holes through the blade.
5. to keep from cutting or peeling up the cement or mortar
6. about 8 inches wide and from 4 to 5 feet long

7. to level concrete after it has been poured
8. edgers
9. cuts a line or groove into the cement to help prevent cracks
10. stiff bristled brushes or brooms

Exercise E-4

Heavy Masonry Equipment

---

1. (1) gin poles
   (2) breast derricks
   (3) pole derricks
2. the pin lewis
3. the steel grabhook
4. (1) hydraulic cutter
   (2) hand splitter
5. a hammer or sledge
6. 14- to 20-inch saw blades
7. It should be cleaned.
8. brick tongs
9. (1) Jitterbug tamper
   (2) Rollerbug tamper
10. to strick off, compact, and float a slab in one pass
11. from 28 to 46 inches
12. to say contraction joints, repair damaged areas, and cut openings in masonry materials
13. the swing-stafe scaffold
14. 120

Exercise F-1

Cement, Lime, Mortar, and Concrete

---

1. (1) the dry process
   (2) the wet process
2. quicklime
3. chemically treated quicklime
4. portland
5. materials that may be added to mortar mixes
6. a dry state
7. sand, gravel, and crushed stone
8. hydration
9. by flooding or mist spraying, adding a damp cover, sealing the materials with waterproof paper or plastic, or spraying on chemical solutions to hold in the moisture
10. air that has been trapped in the mixture, usually during mixing
11. the size of the aggregate

Exercise F-2

Brick, Tile, Block, and Stone

---

1. baked clay
2. (1) building bricks
   (2) facing bricks
   (3) ceramic-glazed structural clay facing tile, facing brick, and solid masonry units
3. The brick is too soft.
4. Hollow tile provides an increase in bulk without a corresponding increase in weight. It can be laid faster and can be readily plastered; it uses less mortar, is more dampproof, and is less likely to convey sound and vibration.
5. a brick substitute that is made from a better quality clay than common bricks
6. 8 by 8 by 16 inches
7. portland cement and aggregates
8. (1) rubble
   (2) ashlar
   (3) trimmings
9. Limestone is formed by the action of water, and granite is formed by heat.
10. light control

Exercise F-3

Metal Ties, Steel Bearing Plates, and Flashing

---

1. The ties have a smaller gage.
2. to attach brick veneer to backing walls
3. with 8-penny nails
4. to attached brick veneer to concrete walls, columns, or beams
5. either copper or zinc-coated steel
6. so support steel beams or girders when they are placed on walls or piers
7. to divert unwanted moisture to the outside of the structure
8. openings that allow the moisture diverted by flashing to be deposited outside the masonry structure
9. because sheathing is not strong enough to hold the nail in place
10. in mortar and placed in a level position

Exercise G-1

Brick Bonds

---

1. bricks that are placed lengthwise on a wall with the longest edges parallel to the face of the wall
2. one that is placed in a vertical position with the face of the brick facing the front of the wall

3. one of the continuous horizontal layers of units that is bonded with mortar
4. the vertical, longitudinal joint between wythes of masonry
5. an English bond
6. It is poured into the cavity or collar joint between wythes of masonry.
7. (1) running bond
   (2) common or American bond
   (3) Flemish bond
   (4) English bond
   (5) stack bond
8. (1) tool
   (2) trowel
9. the weathered joint
10. when a brick is set on edge with the end toward the front of the wall
11. the horizontal layer of mortar on which a masonry unit is laid
12. a hairline crack

Exercise G-2

Reinforced Brick

1. compressive and lateral
2. the weight of the contents of a building
3. the resistance that occurs when a force is applied against a structure
4. The complete unit has a tendency to shorten.
5. shear
6. so that tensile and shearing stresses may be carried
7. the same as that used for other types of brick construction
8. before construction begins
9. maximum bond and compressive and shearing strengths
10. by tapering the bed of mortar
11. (1) low-lift grouting
    (2) high-lift grouting
12. dry mortar
13. when a brick is shoved against the next brick to leave the headjoint full of mortar
14. by feeding small amounts of grout at one time

Exercise G-3

Climatic Conditions

1. efflorescence
2. Keep water off the masonry until after curing has been completed.
3. It causes mortar to set up too fast, to become stiff and hard to apply, and to have less compressive strength.
4. to slow the drying out process
5. the freezing of mortar before it has set or a lack of protection from cold weather during construction

6. 48 hours
7. rapid evaporation
8. erect 45-degree braces to support the wall or add internal reinforcement

Exercise G-4

Preparation of Materials

---

1. those required by the American Society for Testing Materials
2. a weakened structure
3. the amount of water by weight that enters 1 square inch of the brick surface in 1 minute when the surface is immersed in 1/8 inch of water
4. Oversanding causes the mortar to be harder to work and to have weaker bonds.
5. They should be thoroughly soaked.
6. clean, sharp sand
7. the property of the mortar to hold the units of masonry together
8. dry
9. clean water, free from salts, foreign materials, and minerals
10. because enough to stop freezing will weaken the mortar

Exercise H-1

Types of Brick Walls

---

1. climatic conditions and what the structure will be used for
2. (1) wall-bearing construction
   (2) skeleton-frame construction
3. (1) economy of construction
   (2) resistance to lateral forces
4. (1) construction of channels behind the exterior wythe to conduct water to the outside
   (2) provision of a barrier to water penetration behind the exterior wythe
5. the drainage wall
6. the brick-veneer wall
7. to allow for weep holes
8. clips
9. vermiculite and perlite
10. 12 inches
11. (1) metal-tied
    (2) reinforced brick
12. Solid brick walls are used for fire walls, interior load-bearing walls and partitions, and exterior walls in localities where rain is not accompanied by high winds.

Exercise H-2

Construction of Brick Walls

---

1. trigs
2. one course
3. 1/8 inch
4. the corner or lead
5. about 4 feet
6. when two opposite corners or leads have reached the same height but differ in the number of courses on each end
7. with the left edge of the trowel
8. It should be cut off with the trowel and returned to the mortarboard.
9. about 1 inch thick
10. a furrow
11. immediately after the wall has been laid
12. to make the structure more waterproof and to improve its overall appearance

Exercise H-3

Construction of Rubble Stone Walls

---

1. on its broadest face
2. larger stones
3. The stones absorb water from the mortar which weakens the bond between stones.
4. larger than the rest of the wall
5. about 2 inches
6. 3 to 4
7. at least one in each 6 to 10 square feet of wall
8. completely through
9. The stone is not laid in courses.
10. back strains and bruised fingers or hands
11. Use a nonstaining white portland cement when making mortar.

Exercise I-1

Footings

---

1. to distribute the weight of a structure over a larger area of bearing surface
2. of concrete with rods and grillage for reinforcement
3. 2 inches
4. because the next course consisting of headers should be started with a full bond
5. because of the likelihood of freezing
6. They extend on all four sides and are usually much deeper than those designed for walls.
7. Chimney footings must support a higher concentration of weight.
8. in areas with moving soil
9. usually about 3 feet square and 18 inches deep

Exercise I-2

Arch Types, Forms, and Terminology

---

1. the median line of the arch ring
2. creepers
3. the convex curve that bounds the upper extremities of an arch
4. the center unit that wedges the arch in place
5. It is the inclined surface on which the arch joins the supporting wall.
6. It is the undersurface of the arch.
7. It is a pointed four-centered arch of medium rise-to-span ratio.
8. Voussoirs
9. Each brick in the arch acts as a wedge.
10. the jack arch
11. steel lintels
12. the Gothic arch

Exercise I-3

Arch Construction

---

1. temporary shoring or centering
2. to carry the dead load of the arch
3. the compressive and bond strengths of the mortar used
4. by drawing a line from the radius point to the spring point and setting the bevel square to this angle
5. last
6. the joints on the soffit
7. about ten days
8. two or more rings of rowlock headers
9. in the vertical joints
10. a bevel square
11. the arch may fail
12. releasing the wedges

Exercise J-1

Chimneys

---

1. a flue
2. overheated or defective flues
3. at least 2 feet
4. concrete
5. vitrified fire clay at least 5/8 inch thick
6. in masonry chimneys with walls less than 8 inches thick

7. each fireplace, furnace, or boiler
8. 2 inches
9. flashing and counterflashing
10. at least 4 inches
11. a smoke test
12. once a year

Exercise J-2

Fireplaces

---

1. the single-face fireplace
2. because of cross drafts
3. from 30 to 36 inches wide
4. about 32 inches
5. firebrick and fireclay mortar
6. 6 inches
7. It forms a barrier to the downdraft of smoke and deflects it into the ascending column of smoke.
8. below the bottom of the flue, extending the full width of the throat
9. because they give proper form to the chamber and have smooth surfaces
10. the area of the flue and the height of the chimney
11. with ornamental brick or tile
12. to support the masonry
13. the face

Exercise K-1

Fundamentals of Masonry Floors

---

1. (1) mortared joints
   (2) mortarless joints
2. (1) base
   (2) cushion
   (3) wearing surface
   (4) joints
3. between 1/2 and 1 inch thick
4. herringbone and running
5. drainage, freezing, and thawing
6. 1/8 to 1/4 inch per foot
7. Set the pavement directly on pea gravel.
8. to keep the brick from spreading or shifting
9. a terrazzo grinder
10. Air bubbles below the surface may be exposed.
11. masonry silicones

Exercise K-2

Construction of Masonry Floors

---

1. mortar made of one part cement and two parts sand
2. It should be wiped off and the masonry washed.
3. by using a straightedge for each course and laying cross joints to the lines
4. so that no matter what width is used, cuts of the same size will show on each side
5. It eliminates any straight-line joints.
6. in the same way as for unreinforced brick pavement
7. so water will not stand
8. a wooden triangle and a straightedge
9. filling the joints with sand and brushing off the excess
10. to keep the bricks in place, seal the bottom of the joint, and serve as a bed for the reinforcing steel

Exercise L-1

Cleaning New Masonry

---

1. a white, powdery substance, composed of water-soluble salt, that is sometimes seen on masonry structures
2. (1) colorless salts that crystallize in alkaline or neutral solutions
   (2) colored salts that are obtained from acid solutions
3. incorrect cleaning techniques or the wrong type of cleaner
4. water
5. (1) They do not spill as easily.
   (2) They are not as dangerous to handle.
   (3) They cost less to ship.
6. The chief ingredient, sulfmaic acid, sometimes causes efflorescence on masonry units.
7. light-colored brick
8. wooden paddles and scrapers
9. the highest grade, or chemically pure, hydrochloric acid
10. one part acid to 15 parts clean water
11. The acid should be poured into the water.
12. 5 to 10 minutes
13. a cleaning procedure in which sand particles are propelled by high air pressure towarc an object
14. goggles and a respirator

Exercise L-2

Cleaning Old Masonry

---

1. by applying ammonium sulfamate
2. soap, detergents, cold water, and a stiff brush
3. the large volume of water needed
4. high-pressure cleaning
5. hard brick, rough-finished limestone, and unpolished granite
6. the wet-aggregate cleaning method
7. chemicals and steam
8. by rubbing with steel wool or sandblasting
9. hinges, wrought iron, or other metal fixtures

Exercise M-1

Concrete-Block and Cut-Stone Trim

---

1. a concave type
2. at window and door openings
3. by using nonstaining paint or lime mortar mixed with white nonstaining cement
4. ashlar
5. two
6. a wooden wedge
7. cut stone
8. more expensive structures
9. at the first-floor level
10. (1) plain sawed
    (2) molded
11. by grouting and pointing up with an elastic cement
12. ornamentation

Exercise M-2

Setting Stones

---

1. the elevation and sections of the job, and explanations
2. the failure to insert and build in metal anchors
3. a noncorrosive metal or one with a noncorrosive coating
4. keys of stone or slate in the form of cubes
5. the weight of the stone that needs supporting
6. one that will not darken or discolor the mortar
7. on platforms
8. acid-base
9. on unexposed surfaces
10. They should be soaked overnight.

Exercise N-1

Setting Up a Masonry Business

---

1. sole ownership
2. One person supplies the capital, and one runs the business.
3. from the Internal Revenue Service
4. the taxable wage base of a quarter (3 months)
5. It covers liability if a worker is injured on the job. This may include driving to and from the building site.
6. The owner can pay cash for materials and not have to pay interest. Materials can be purchased with cash discounts, and timesaving equipment can be bought.
7. a two-way radio or CB
8. scheduling problems
9. Draw up a binding contract or agreement.
10. so the risk to the lending institution is less
11. late material deliveries

Exercise N-2

Human Relations in a Business

---

1. the person's experience, attitude, and abilities
2. state employment agencies, private employment agencies, recruiting firms, unions, and various social service organizations
3. through current employees
4. Check their backgrounds.
5. This gives both you and the applicant a chance to ask and answer questions about the job.
6. Compile and review all information.
7. an orientation period
8. the job responsibilities
9. competence, patience, organization, the ability to communicate, and a desire to support the trainee
10. so employees will form safety habits that may save time, expense, and suffering
11. (1) satisfaction in the job itself
    (2) pride in co-workers
    (3) acceptance of pay policies and promotion opportunities
    (4) a feeling of belonging to the company
12. Productivity drops.
13. high employee turnover, complaints, absenteeism, and low productivity

Answers to Assignment Tests

Test A-1
How to Use This Manual
1. student's manual
2. objectives
3. exercise
4. objectives
5. c. multiple-choice

Test A-2
Careers in the Masonry Field
1. granite
2. Mortar
3. 75
4. 144
5. 17

Test B-1
Adding and Subtracting Common Fractions
1. two
2. numerator
3. improper
4. Mixed
5. a. 19/35
    b. 5/18
6. a. 5/8
    b. 19/40

Test B-2
Multiplying and Dividing Common Fractions
1. multiplicand
2. c. divisor
3. invert
4. a. 8/21
    b. 2/15
5. a. 1 3/4
    b. 2

Test B-3
Decimal Fractions and Conversions
1. 0.02
2. 10.7
3. a. 0.166
    b. 0.6
4. a. 3/4
    b. 19/400
5. metric

Test B-4
Percentage, Ratio, and Proportion
1. a. 2/5
    b. 5/100
2. a. 4%
    b. 10%
3. a. 0.03
    b. 0.87
4. equal

Test B-5
The Metric System
1. grams
2. liter
3. quarts
4. gram
5. 39.37

Test B-6
Developing Areas, Perimeters, and Circumferences
1. 144
2. 540
3. 46
4. 50.27

Test C-1
General Safety
1. acid
2. respirator
3. 90
4. transparent
5. one fourth

Test C-2
Handling Storage
1. legs
2. authorized
3. squatting
4. glass

Test C-3
Hand and Power Tool Safety
1. Forcing
2. rough
3. respirator
4. sharpening

Test D-1
Reading Blueprints
1. Visible
2. numbers
3. Phantom
4. Symbols
5. cutaway

Test D-2
Angles and Shapes
1. Vertical
2. isosceles
3. circumscribed
4. obtuse
5. 90-degree

Test D-3
Types of Drawings
1. orthographic projection
2. b. parallel
3. largest
4. Symbols
5. horizon

Test E-1
Trowels, Hammers, and Chisels
1. c. four
2. bolster
3. board
4. rough
5. trowel

Test E-2
Measuring and Leveling Tools
1. cutting
2. line
3. trig
4. guide

Test E-3
Mixing and Smoothing Tools
1. dries/hardens
2. hod
3. two holes
4. level
5. cracks

Test E-4
Heavy Masonry Equipment
1. pin
2. hydraulic
3. tongs
4. screeds
5. Joint

Test F-1
Cement, Lime, Mortar, and Concrete
1. quicklime
2. Portland
3. admixtures
4. hydration
5. Entrained

Test F-2
Brick, Tile, Block, and Stone
1. clay
2. dull
3. Terra-cotta
4. aggregates
5. water

Test F-3
Metal Ties, Steel Bearing Plates, and Flashing
1. corrugated
2. copper
3. bearing
4. Flashing

Test G-1
Brick Bonds
1. soldier
2. stretchers
3. weathered
4. bed

Test G-2
Reinforced Brick
1. Tension
2. shearing
3. Dry
4. 1/2
5. stirred

Test G-3
Climatic Conditions
1. Efflorescence
2. Lime
3. 48 hours
4. evaporation

Test G-4
Preparation of Materials
1. Testing
2. bonds
3. bond
4. dry

Test H-1
Types of Brick Walls
1. skeleton-frame
2. drainage
3. brick-veneer
4. Clips
5. 12

Test H-2
Construction of Brick Walls
1. course
2. 1/8 inch
3. left
4. furrow

Test H-3
Construction of Rubble Stone Walls
1. broadest
2. 2
3. bending
4. Random
5. white

Test I-1
Footings
1. 2
2. 3/4
3. piers/columns
4. moves

Test I-2
Arch Types, Forms, and Terminology
1. extrados
2. keystone
3. undersurface
4. wedge
5. crown

Test I-3
Arch Construction
1. dead
2. mortar
3. soffit
4. vertical
5. bevel

Test J-1
Chimneys
1. overheated
2. Concrete
3. vitrified
4. 2
5. smoke

Test J-2
Fireplaces
1. fireclay
2. flue
3. height
4. lintel
5. drafts

Test K-1
Fundamentals of Masonry Floors
1. cushion
2. herringbone
3. spreading/shifting
4. grinder
5. silicones

Test K-2
Construction of Masonry Floors
1. face
2. straight-line
3. triangle
4. seals

Test L-1
Cleaning New Masonry
1. salts
2. techniques
3. paddles/scrapers
4. 15
5. respirator

Test L-2
Cleaning Old Masonry
1. sulfamate
2. high-pressure
3. aggregate
4. sandblasting

Test M-1
Concrete-Block and Cut-Stone Trim
1. concave
2. ashlar
3. setting
4. molded
5. ornamentation

Test M-2
Setting Stones
1. elevation
2. weight
3. Acid-base
4. unexposed

Test N-1
Setting Up a Masonry Business
1. Sole
2. limited
3. quarter
4. scheduling
5. binding

Test N-2
Human Relations in a Business
1. backgrounds
2. review
3. orientation
4. responsibilities
5. Production

Assignment Tests and Work Sheet for

Bricklayer and Stonemason

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- Instructors who do not want to reproduce the material can purchase separate sets of this section from the Extension Instruction and Materials Center, The University of Texas at Austin, P.O. Box 7218, Austin, Texas 78713.
- Each assignment test is based on a specific assignment.
- The work sheet is provided for use as a weekly log. The sheet lists the contents of the student's manual to use in coordinating assignments with work experiences.

Test A-1

How to Use This Manual

---

1. A ____________________ is designed to present technical instructions, procedures, and illustrations to the student.

2. The assignment ________________ should be studied before reading the information part of the assignment.

3. All assignment _______________ answers should be written in the form of complete sentences.

4. It is assumed that the assignment _______________ have been met when the exercise questions have been answered correctly.

5. Assignment test questions in this manual are either fill-in-the-blank or—

   a. true-false.
   b. matching.
   c. _________________.
   d. essay.

Test A-2

Careers in the Masonry Field

---

1. Stonemasons work with natural stones of limestone, ____________, and marble.
2. __________________ is used as a bed for brick.
3. About _______ percent of the bricklayers are employed by trade, building, or general contractors.
4. A masonry apprentice is required to have _______ hours of classroom instruction.
5. An applicant for the masonry apprenticeship program must be at least ______ years old.

Test B-1

Adding and Subtracting Common Fractions

---

1. The fraction 1/3 contains _____ sixths.

2. The number above the horizontal line in a fraction is called the ______________.

3. A(n) ______________ fraction has a numerator that is larger than the denominator.

4. ____________ numbers are those that contain both a whole humber and a proper fraction.

5. Work the following addition problems:

   a. 2/5 + 1/7 = __________

   b. 1/9 + 1/6 = __________

6. Work the following subtraction problems:

   a. 3/4 - 1/8 = __________

   b. 7/8 - 2/5 = __________

Test B-2

Multiplying and Dividing Common Fractions

---

1. A number that is multiplied by another number is a ________________.

2. A ______________ is a number that divides into a dividend.

   a. quotient
   b. multiplier
   c. divisor
   d. product

3. To turn a fraction upside down means to ____________ it.

4. Work the following multiplication problems:

   a. 3/7 x 8/9 = __________

   b. 1/5 x 2/3 = __________

5. Work the following division problems:

   a. 3 1/2 ÷ 2 = __________

   b. 1/2 ÷ 1/4 = __________

Test 8-3

Decimal Fractions and Conversions

---

1. The decimal fraction for two-hundredths is ______________.

2. The decimal fraction 2.5 added to 8.2 equals ______________.

3. Convert the following fractions to decimals:

   a. 1/6 = ______________

   b. 3/5 = ______________

4. Convert the following decimals to fractions:

   a. 0.75 = ______________

   b. 0.0475 = ____________

5. Fractional quantities in the ______________ system are always expressed as decimal fractions.

Test B-4

Percentage, Ratio, and Proportion

---

1. Convert the following percentages to fractions:

   a. 40% = __________

   b. 5% = __________

2. Convert the following ratios to percentages:

   a. 1:25 = __________

   b. 1:10 = __________

3. Convert the following percentages to decimals:

   a. 3% = __________

   b. 87% = __________

4. A proportion is the statement of an __________ relationship between two ratios or fractions.

Test B-5

The Metric System

---

1. One ounce contains 28.35 ________________.

2. The unit of capacity in the metric system is the ________________.

3. There are 1.057 __________________ in a liter.

4. The unit of weight in the metric system is the ____________________.

5. There are ________________ inches in a meter.

Test B-6

Developing Areas, Perimeters, and Circumferences

---

1. The floor area of a patio is 12 feet by 12 feet is ______________ square feet.
2. There are ____________ square feet in a room that is 15 feet wide and 36 feet long.
3. The perimeter of a rectangle that is 9 feet wide and 14 feet long equals ____________ feet.
4. The circumference of a circle having a diameter of 16 feet is ______________ feet.

Test C-1

General Safety

---

1. The use of ________________ when cleaning masonry materials may be a health threat to masonry workers.

2. A NIOSH-approved _________________ should be worn when working around dusts or fumes.

3. Hearing may be damaged if noise levels exceed ________ decibels.

4. Wooden ladders should have a _________________ coating so you can see any cracks or flaws that might develop.

5. The base of a ladder should be _______________ of its working length away from a wall or support.

Test C-2

Handling and Storage

---

1. Hand-lifting operations should be done with the hands and ________________.
2. Only ____________________ persons should be permitted in storage areas.
3. A ____________________ position should be assumed to make a heavy lift.
4. Acid should be stored in _________________ containers.

Test C-3

Hand and Power Tool Safety

---

1. ________________ a dull tool often causes accidents.

2. A hammer head should be flat, dry, and slightly ________________.

3. When operating a masonry saw, a face mask or goggles and a ________________ should be worn.

4. Special care should be taken with masonry cutters when removing, replacing, and ________________ of the blades.

Test D-1

Reading Blueprints

---

1. ________________ lines indicate the outside borders and edges or lines that are visible within the object.

2. Dimension lines are broken to allow space for dimension ________________.

3. ______________ lines show positions or paths of movable objects or parts.

4. ______________ are used on a blueprint when there is not enough room on the drawing to show a complete object.

5. Sections show a ____________________ of an object, building, or part of a building.

Test D-2

Angles and Shapes

---

1. ________________ lines should be drawn with a triangle used on a T square.

2. A(n) ____________________ triangle is one that has two equal sides and two equal angles.

3. A ________________________ plane figure is one that encloses another figure.

4. The three types of angles are the acute angle, the _________________ angle, and the right angle.

5. A rhomboid is a figure with parallel sides of different lengths and with no ____________________ angles.

Test D-3

Types of Drawings

---

1. Another name for a working or three-view drawing is ______________________.

2. In an isometric drawing, the receding lines are—

   a. tangent.

   b. ______________________.

   c. at 90 degrees.

   d. perpendicular.

3. It is better to place the __________________ dimension in the front view of an oblique drawing.

4. ____________________ must be used in floor plans in order to show the type of material that is to be used.

5. Most perspective drawings are based on the idea that all lines seem to disappear at the ______________________.

Test E-1

Trowels, Hammers, and Chisels

---

1. The usual number of bricks that are spread with mortar at one time are—

   a. two.

   b. three.

   c. ______.

   d. five.

2. A blocking chisel is sometimes called a ________ chisel.

3. Mortar is transferred to the brick from a mortar tub or _____ during the bricking operation.

4. A brick hammer is used for making _____ breaks on the brick.

5. The _______ is the most important tool used by the masonry worker.

Test E-2

Measuring and Leveling Tools

---

1. The mason uses a small steel square for marking bricks for ________________.

2. A mason's __________________ is attached to a masonry guide or a story pole.

3. A __________________ is used when there is a sag in the mason's line.

4. The masonry _________________ has replaced the story pole.

Test E-3

Mixing and Smoothing Tools

---

1. Mortar quickly ______________ and ______________ if it is spread all over the mortarboard.

2. A mortar ____________ is a V-shaped box for carrying mortar.

3. A mortar hoe has ______________________ through the blade.

4. A screed is used to ________________ concrete after it has been poured.

5. A groover or jointer cuts a line or groove into the cement to help prevent ____________.

Test E-4

Heavy Masonry Equipment

---

1. The ______________ lewis is used for lifting stones occurring in the horizontal course of the cornice.
2. A masonry cutter may be either a hand splitter or a ____________________ cutter.
3. Brick __________________ are used to carry small quantities of brick.
4. Power __________________ are used to strike off, compact, and float a slab in one pass.
5. __________________ cutters are used to saw contraction joints, repair damaged areas, and cut openings in masonry materials.

Test F-1

Cement, Lime, Mortar, and Concrete

---

1. Hydrated lime is chemically treated ________________________.

2. ________________________ cement is the type of cement normally used in mortar.

3. Materials that may be added to mortar mixes are called ________________________.

4. The process of ________________________ causes concrete to harden.

5. ________________________ air is air that has been trapped in the mixture (usually during mixing).

Test F-2

Brick, Tile, Block, and Stone

---

1. Bricks are composed of baked ______________________.
2. When two bricks are struck against each other, a ________________ sound indicates the brick is too soft.
3. ______________________ is a brick substitute that is made from a better quality clay than common bricks.
4. Concrete blocks are made of portland cement and ______________________.
5. Limestone is formed by the action of ____________________.

Test F-3

Metal Ties, Steel Bearing Plates, and Flashing

---

1. The ____________________ metal tie is used to attach brick veneer to backing walls.

2. The Z tie is constructed of either __________ or zinc-coated steel.

3. Steel ____________________ plates are used to support steel beams or girders when they are placed on walls or piers.

4. ____________ is used in masonry work to divert unwanted moisture to the outside of the structure.

Test G-1

Brick Bonds

---

1. A __________ brick is one that is placed in a vertical position with the face of the brick facing the front of the wall.

2. An English bond alternates courses of headers and _____________.

3. The _________________ mortar joint is recognized as one of the best of troweled joints.

4. A _____ joint is the horizontal layer of mortar on which a masonry unit is laid.

Test G-3

Climatic Conditions

---

1. ________________ may take place when salts dissolve and leave a residue on masonry materials.

2. ______ is sometimes added to mortar on hot, dry days to slow the drying out process.

3. After mixing mortar, allow at least ________ before exposing it to freezing weather.

4. Windy conditions during hot weather may cause rapid ______________________ in mortar.

Test G-2

Reinforced Brick

---

1. ______________ stress occurs when applied loads tend to pull brick units apart.
2. Reinforcement steel should be placed where tensile and __________ stresses occur.
3. ______ mortar should not be allowed to drop into the grout space at any time.
4. It is permissible for the mortar to protrude as much as ______ inch into the grout cavity.
5. Grout should be ______________________ before use in order to avoid having the aggregate separate.

Test G-4

Preparation of Materials

---

1. Masonry materials should conform to standards and specifications required by the American Society for ___________ Materials.

2. Oversanding causes mortar to be harder to work and to have weak ________.

3. A ________________ is the property of the mortar to hold the units of masonry together.

4. All ingredients to be used for mortar should be in a ________________ condition during the first mix.

Test H-1

Types of Brick Walls

---

1. The two types of basic structural designs for buildings are wall-bearing and ____________________ construction.

2. The ____________ wall should be constructed in a locality that is subject to severe weather.

3. The ____________________ wall is usually used for residential construction.

4. __________ are used to attach 2-by-2 inch furring strips in the SCR brick wall.

5. The overall thickness of a masonry-bonded hollow wall is ___ inches.

Test H-2

Construction of Brick Walls

---

1. The line should be raised one ________ at a time.
2. During construction, a brick should be laid about ___________ from the line.
3. A right-handed person should pick mortar up with the ______ edge of the trowel.
4. A ____________ should be made in the center of the bed joint before the brick is inserted.

Test H-3

Construction of Rubble Stone Walls

---

1. Each stone in a wall should be placed on its ____________ face.
2. Mortar beds for footing stones should be about ___ inches deep.
3. At least one ______________ stone should be placed in each 6 to 10 square feet of wall.
4. ___________ rubble stones are not laid in courses.
5. To prevent staining to the stone, a nonstaining __________ portland cement should be used when making mortar.

Test I-1

Footings

---

1. The maximum projection of one course beyond the one above it during brick footing construction is ____ inches.

2. The first course of a brick footing should be started with a _____ bat.

3. Footings for __________ and _____________ should extend on all four sides and much deeper than those designed for walls.

4. Brick footings should not be used in areas where the soil __________.

Test I-2

Arch Types, Forms, and Terminology

---

1. An __________ is the convex curve that bounds the upper extremities of an arch.
2. A __________________ is the center unit that wedges the arch in place.
3. A soffit is the ______________ of the arch.
4. An arch supports weight because each brick in the arch acts as a ___________.
5. The Gothic arch is best if the arch load comes at the __________.

Test I-3

Arch Construction

---

1. The purpose of centering is to carry the _________ load of the arch.

2. The structural strength of an arch depends on the compressive and bond strengths of the __________ used.

3. The joints on the __________ are finished after the center has been removed.

4. The difference of the dimensions of the intrados and extrados in a jack arch are in the ______________ joints.

5. A _____________ square is used to measure the cut of the skewbacks in a segmental arch.

Test J-1

Chimneys

---

1. Most chimney fires are caused by ________________ or defective flues.
2. ______________ should be used as a footing for a chimney.
3. Flue linings should be made of ________________ fire clay.
4. A space of ____ inches should be left between the chimney walls and all wooden beams or joists.
5. A __________ test is used to see if there are leaks in the chimney.

Test K-1

Fundamentals of Masonry Floors

---

1. The four construction elements for interior floors are the base, the ___________, the wearing surface, and the joints.

2. When using mortarless joints in paving, the _____________ or running bonds are recommended.

3. Edging should be placed around exterior paving to keep the brick from ____________ or _________________.

4. A terrazzo ________________ is used to give a smooth finish to laid brick.

5. Masonry ______________ are often used for sealing brick floors.

Test J-2

Fireplaces

---

1. A combustion chamber should be lined with fire brick and ____________ mortar.

2. The smoke shelf is located below the bottom of the __________.

3. Wind and smoke speeds in the flue are affected by the area of the flue and the _______________ of the chimney.

4. A _____________ must be installed across the top of the fireplace opening to support the masonry.

5. Cross ____________ cause many problems in multiple-faced fireplaces.

Test K-2

Construction of Masonry Floors

---

1. Mortar made of one part cement and two parts sand is used to fill __________ joints in basket-weave paving.

2. By using the herringbone pattern, _______________ joints are eliminated.

3. When constructing diagonal basket-weave paving, a wooden _______________ and straightedge are used.

4. Mortar used in reinforced brick pavement keeps the bricks in place, __________ the bottom of the joint, and serves as a bed for the reinforcing steel.

Test L-1

Cleaning New Masonry

---

1. Efflorescence is composed of water-soluble ________.

2. Improper cleaning of masonry is caused by incorrect cleaning __________________ or using the wrong type of cleaner.

3. Wooden ____________ and _________________ are used to remove large particles of dry mortar from masonry.

4. The acid dilution used for cleaning light brick is one part acid to _______ parts clean water.

5. Goggles and a ________________ should be worn during sandblasting operations.

Test L-2

Cleaning Old Masonry

---

1. Moss may be removed from old masonry by using ammonium ______________________.

2. The most commonly used cleaning method for old masonry is ____________________ cleaning.

3. The wet-______________ cleaning method is effective for carvings or ornamentation.

4. Dry paint should be removed by either rubbing with steel wool or ___________________________.

Test M-1

Concrete-Block and Cut-Stone Trim

---

1. A ____________ type of mortar joint is best for concrete-block construction.
2. Stone veneer is called __________.
3. A wooden wedge is sometimes used to keep stones in place during __________.
4. Cut-stone copings are either plain sawed or ________________.
5. Quoins are used in stone construction for ________________.

Test M-2

Setting Stones

---

1. A stone-setting drawing contains the _______________ and sections of the job and explanatory details.

2. The size of props depends on the __________ of the stone that needs supporting.

3. ___________________ solutions should never be used for cleaning stones.

4. If crowbars or pinch bars must be used to handle stone, they should be used on ___________________________ surfaces.

Test N-1

Setting Up a Masonry Business

---

1. __________ ownership is the form of ownership used by most masonry contractors.

2. One person supplies the capital and another runs the business in a _______________ partnership.

3. State unemployment taxes are usually based on the taxable wage base of a ______________.

4. An understaffed operation causes ________________ problems.

5. A _________________ contract or agreement should be drawn up before construction begins.

Test N-2

Human Relations in a Business

---

1. Owners of a masonry business can evaluate potential employees by checking their ______________________.

2. The last step in the selection process is to compile and ____________ review all information.

3. All new employees should have a(n) ________________ period.

4. The length of the training period depends on the job ______________________.

5. __________________ drops when there is poor morale.

CONTENTS OF STUDENT'S MANUAL

Section A. Introduction to This Manual
- A-1: How to Use This Manual
- A-2: Careers in the Masonry Field

Section B. Basic Mathematics
- B-1: Adding and Subtracting Common Fractions
- B-2: Multiplying and Dividing Common Fractions
- B-3: Decimal Fractions and Conversions
- B-4: Percentage, Ratio, and Proportion
- B-5: The Metric System
- B-6: Developing Areas, Perimeters, and Circumferences

Section C. Safety
- C-1: General Safety
- C-2: Handling and Storage
- C-3: Hand and Power Tool Safety

Section D. Drawings and Blueprints
- D-1: Reading Blueprints
- D-2: Angles and Shapes
- D-3: Types of Drawings

Section E. Masonry Tools and Equipment
- E-1: Trowels, Hammers, and Equipment
- E-2: Measuring and Leveling Tools
- E-3: Mixing and Smoothing Tools
- E-4: Heavy Masonry Equipment

Section F. Masonry Materials
- F-1: Cement, Lime, Mortar, and Concrete
- F-2: Brick, Tile, Block, and Stone
- F-3: Metal Ties, Steel Bearing Plates, and Flashing

Section G. Elements of Masonry Construction
- G-1: Brick Bonds
- G-2: Reinforced Brick
- G-3: Climatic Conditions
- G-4: Preparation of Materials

Section H. Wall Construction
- H-1: Types of Brick Walls
- H-2: Construction of Brick Walls
- H-3: Construction of Rubble Stone Walls

Section I. Footings and Arches
- I-1: Footings
- I-2: Arch Types, Forms, and Terminology
- I-3: Arch Construction

Section J. Chimneys and Fireplaces
- J-1: Chimneys
- J-2: Fireplaces

Section K. Floors and Pavements
- K-1: Fundamentals of Masonry Floors
- K-2: Construction of Masonry Floors

Section L. Cleaning Clay Products
- L-1: Cleaning New Masonry
- L-2: Cleaning Old Masonry

Section M. Concrete Masonry and Stone Construction
- M-1: Concrete-Block and Cut-Stone Trim
- M-2: Setting Stones

Section N. Owning a Masonry Business
- N-1: Setting Up a Masonry Business
- N-2: Human Relations in a Business

WORK SHEET

FOR COORDINATING JOBS WITH RELATED INSTRUCTION USING

BRICKLAYER AND STONEMASON

This form is for your convenience in planning and keeping records of training. Contents of the student's manual are at the left. The columns below provide space for listing job experiences for the individual student and assignment numbers and other references related to each job. Blanks are large and divided by days so the teacher and student can list other information that might be useful in a weekly log.

Student ______________________________

Training Station ______________________________

JOB EXPERIENCES	RELATED INSTRUCTION
Monday Work Hrs:	
Tuesday Work Hrs:	
Wednesday Work Hrs:	
Thursday Work Hrs:	
Friday Work Hrs:	